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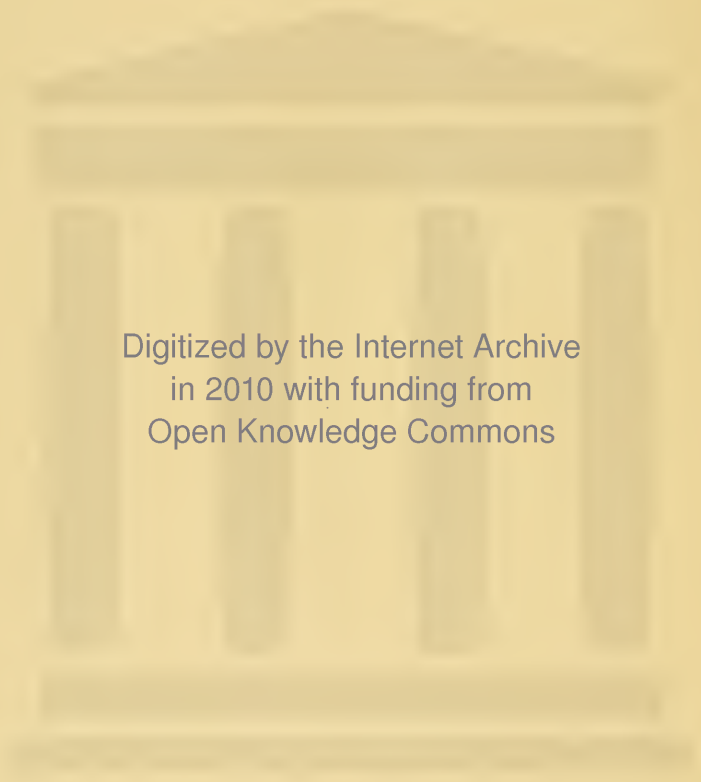
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A MANUAL AND ATLAS
OF
ORTHOPEDIC SURGERY.

YOUNG.



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A MANUAL AND ATLAS

OF

ORTHOPEDIC SURGERY

INCLUDING THE HISTORY, ETIOLOGY, PATH-
OLOGY, DIAGNOSIS, PROGNOSIS, PROPHY-
LAXIS, AND TREATMENT OF DEFORMITIES

BY

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MEDICAL ASSOCIATION, ETC.

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PREFACE.

This Manual and Atlas of Orthopedic Surgery is the result of an experience of twenty years devoted to the study of this subject in the dispensaries and wards of the large hospitals of Philadelphia and elsewhere. During the preparation of the work every available treatise upon the subject has been consulted, in the effort to present it in such a manner as to be of practical use to the general practitioner as well as to the student of medicine. The work has been divided into two parts, the first devoted to General Orthopedic Surgery and the second to Special Orthopedic Surgery, in conformity with the plan adopted by the best Continental writers. The chief object in view has been to include in the work everything within the scope of orthopedic surgery, without encroaching upon the field of general surgery or any other specialties.

The writer is indebted to Professor DeForest Willard, of the University of Pennsylvania, for many acts of kindness and for many excellent opportunities of studying this important subject of deformities.

Great care has been taken in selecting the illustrations, which have been chosen from a large collection obtained from many sources. The art photographs were kindly loaned from the very valuable collection of Hudson Chapman, of Philadelphia.

He is also indebted to his foreign confrères for the loan of valuable photographs of rare and severe deformities, especially to Robert Jones, of Liverpool, and Professors Lange, of Munich, Heussner, of Bremen, Schanz, of Dresden, and Hovorka, of Vienna.

He also acknowledges his indebtedness to Dr. E. H. Nichols, of Boston, Dr. Joseph N. Spellissy, of Philadelphia, and Dr. Wallace Blanchard, of Chicago, for timely photographs.

The Mutter Museum of the Philadelphia College of Physicians, and the Wistar Institute of Anatomy, through the kindness of Dr. Greenway, and also the Army Medical Museum, have all contributed generously toward the illustrations, adding materially to the completeness of this part of the book. The x-ray photographs are from the valuable collections of Professor Goodspeed and Dr. Kassabian. Permission has been kindly accorded by "Medicine" for the use of certain typical illustrations of scoliosis, which had been previously

published by the writer in that journal. To James F. Wood, of Philadelphia, the work owes much of its excellence as to photographic technique.

The statistical tables upon Tuberculous Joint Disease were prepared by Dr. Harold Wood, and Dr. Thomas H. Evans has contributed the Italian and Spanish synonyms.

The writer is also indebted to Dr. James A. Kelly for valuable assistance in the preparation of the text, particularly in the section upon Tuberculous Joint Disease.

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ORTHOPEDIC SURGERY.

PART I.

GENERAL ORTHOPEDIC SURGERY.

CHAPTER I.

INTRODUCTION AND HISTORY.

The word "orthopedy" (from *ὀρθός*, "straight," and *παῖς*, "child")—Fr., *orthopédie*; Ger., *orthopädie*; It., *ortopèdia*; Span., *ortopedia*—according to its derivation and its earlier use implies the art of removing deformities in young children. In the present day its meaning has been extended to apply to the treatment of deformities in persons of all ages. From its derivation, again, it might be taken to embrace the rectification of a great variety of abnormal conditions in which deformity is a conspicuous feature—the reduction of dislocations, the removal of tumors, etc.; but in modern practice the application of the term is limited to certain kinds of deformities, especially those of a chronic and progressive character.

Orthopedic surgery may be defined as that department of surgical science which includes the preventive, mechanical, and operative treatment of chronic and progressive deformities.

As a special branch of medicine its influence extends in three directions. By its employment of gymnastics it enters the field of hygiene; by its operative procedures it supplements, but does not invade, the realm of general surgery; and by its therapeutic prevention and cure of deformities it advances in the path of practical medicine.

The orthopedic surgeon of today must be an educated surgeon in every sense of the word. Carefully trained in clinical and operative surgery, thoroughly skilled in mechanical principles, he must be equally prepared in all three branches of his special art: the treatment and prevention of orthopedic diseases, the application of apparatus, and the performance of operations—in other words, must be a physician, a mechanic, and a surgeon. In this

respect the orthopedist most resembles the ophthalmologist, who must treat disease, refract, and operate. As in ophthalmic practice refraction forms the greater part of the work, so also in orthopedic surgery, measurement and the application of mechanical appliances will demand the greatest attention.

In the medical schools and universities of this country every student before graduating is instructed in the fundamental principles and practice of the orthopedic art. Particularly is he instructed in the use and application of such appliances as he can manufacture for himself.

The increasing interest in this subject is well indicated in the establishment of special dispensaries, practical courses, and clinical professorships in all the colleges and post-graduate schools in this country. In many of these, moreover, as the University of Pennsylvania, the New York Orthopedic Hospital, and the Boston Children's Hospital, special machine shops are attached, in which, under the direct supervision of the surgeon, the mechanical appliances are made. The orthopedic art is thus elevated in importance as a special branch of surgery, and the orthopedic surgeon is advanced in dignity and reputation.

HISTORY.

The study of the history of orthopedy is best divided into three periods: the precontinental period; the continental and early English period, the seventeenth and eighteenth centuries; and a later period embracing the nineteenth century and including special reference to American contributions and progress.

Precontinental Period.—The history of orthopedics is coeval with medicine itself, but we find in the oldest sources of medical investigation only sparse references to this subject. Among the Chinese, Egyptians, and Hindus the surgery of deformities is only a reflection of ancient tradition. The earliest writings upon the causes of congenital deformity and massage of the body are found in the *Ajura-Veda* of Susruta, about 800 B. C. In the writings of Hippocrates, 500 B. C., collected by Polybius, there are many references to this subject, especially to spinal deformities and congenital dislocation of the hip-joint and ankle-joint. He displayed an intimate knowledge of club-foot in his treatise "On Articulations," and described a method of correcting infantile deformity which is still employed. This celebrated Greek physician opposed the violent extension and counter-extension with pressure as practised upon hunchbacks, and he finally describes the spinal inflammation accompanied

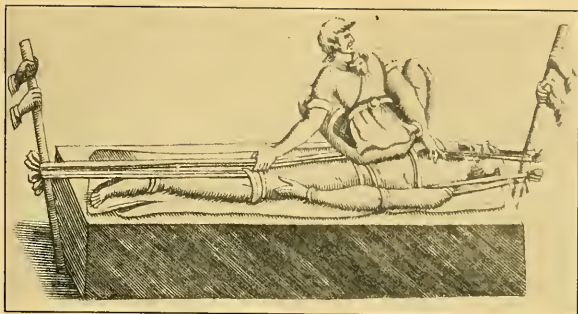


FIG. 1.

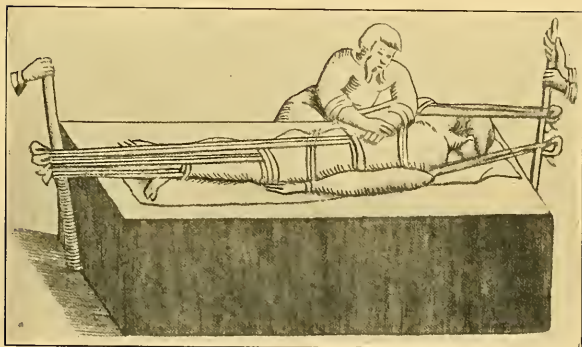


FIG. 2.

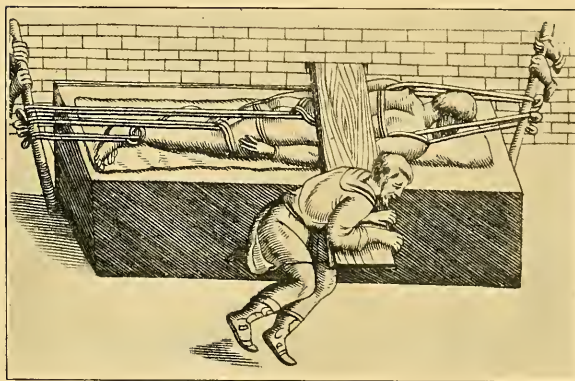


FIG. 3.

FORCIBLE CORRECTION IN TIME OF THE ANCIENTS.

by pain—the “angina of Hippocrates.” He employed gymnastics for the development of the muscular system and employed machines alone in the treatment of deformities.

↳ Celsus, 13 to 55 A. D., also employed active and passive gymnastics for the relief of deformities, with massage before and after. He does not even mention club-foot, foreshadowing the darkness and ignorance of the Middle Ages.

Soranus, 110 A. D., refers to the prevalence of crooked legs in Rome, and censures the women of his time for allowing children to walk too early.

Galen, 130 to 206 A. D., describes spine disease, mentions the treatment of scoliosis, and differentiates this disease from lordosis and kyphosis, and refers in several places to knock-knee.

Cælius Aurelianus, 210 A. D., employed gymnastics and splints for paralysis, and Antillus, about 400 A. D., performed tenotomy for contractures and ankylosis.

From the early Arabian physicians a few imperfect compilations, more or less interpolated, with almost no original work, are all that has been left to medical science. The earliest deformity discussed by them was excessive callus, and Rhazes, 852 A. D., in his “Continent,” and Avicenna, 980 A. D., in the “Canon,” repudiated the use of all rough and violent methods.

As medicine as a science advanced, the radical cure of hare-lip described by Galen, Celsus, and the Arabian physicians, became a common operation. The plastic art was well understood, and section of the sternocleidomastoid muscles for the relief of wry-neck was frequently performed.

During the Middle Ages cripples were considered as objects of Divine wrath, were regarded as subjects of ill omen, and were treated with horror and disgust. Superstition withheld aid from these unfortunates and forbade even the mention of their existence. Influenced by this belief in the displeasure of the divinities, and also desiring to avoid the baneful influence of the deformed upon the *enceinte*, the practice became prevalent, under the barbarous laws of Lycurgus, of allowing cripples to perish from want and neglect, or of destroying them by casting them into the Eurotas, as was done in Sparta.

This effort to preserve the fitness of races is mentioned by Cicero as existing among the Romans, and it may occasionally be observed among aboriginal tribes even at the present time.

Continental and Early English Period.—The oppressive gloom of the Dark Ages yielded slowly to the dawn of intellectual light, and the opposition

of Islam to Christendom was ended. Feudalism was replaced by the formation of distinctive nationalities, and medicine as a science once more began its forward march.

The only contribution of any importance for over a century was that upon the diseases of the hip and spine by Albucanus, 1100 A. D. The real foundation of orthopedic surgery was laid by Ambroise Paré, 1561, who invented a steel corset consisting of a carapace and plastron in which the spine of a crooked person was laced, and who described the treatment of club-foot and rickets. Severinus Arcaeus, a Spanish contemporary of Paré, invented some apparatus; Fabricius Hildanus, 1641, devised a splint for straightening the elbow and knee, and for many years mechanical appliances were the only means employed in the treatment of deformities.

The year 1641 marks an important advance in the history of orthopedics, when Isaac Minnius performed an open section of the sternomastoid for torticollis, and in 1660 Glisson introduced suspension of the body for the correction of spinal affections, and published his celebrated work upon rickets.

As a special branch of surgery orthopedics dates its existence from the time of Andry, 1741, called by some the "father of orthopedic surgery," who coined for it a name in his book upon "The Art by which Bodily Deformities of Children are Prevented and Improved." In 1778 André Venel settled in Orb, Switzerland, and founded an orthopedic institution. During the latter part of the eighteenth century important advances were made by Ludwig, 1772, and Bottcher, 1792, in Germany; Petit, 1758, Levacher, 1768, and Portal, 1779, in France; and Pott, 1779, and Darwin, 1795, in England.

The practice of orthopedic surgery was actively pursued at this time by Naumberg, 1796, and Brucken, 1798, in Germany; Typhaine and Verdier, 1784, in France; and Sheldrake and Jackson, 1794, in England; and the way was prepared for the brilliant discovery of subcutaneous tenotomy and its establishment as a principle in operative medicine.

The Nineteenth Century.—The activity manifested at the close of the eighteenth century increased, and with the advent of the nineteenth century began the renaissance of orthopedics, the real scientific study of deformities. The empirical use of mechanical appliances which formed the fundamental basis of the treatment of deformities by the earlier surgeons was succeeded by the study of the anatomy and pathology of these affections and their rational treatment. In 1802 Scarpa invented a club-foot shoe which has since been used as a model, and gave a complete description of this affection which has

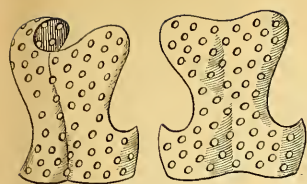


FIG. 4.—STEEL CUIRASS (Paré, 1579).

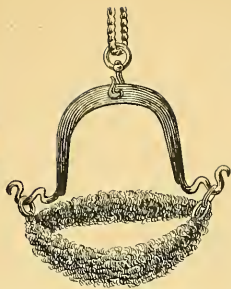


FIG. 5.—SUSPENSION APPARATUS (Van Nuck, 1606).

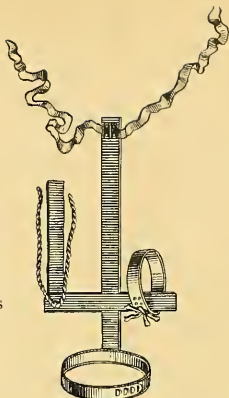


FIG. 6.—SPINE BRACE WITH CHIN PIECE (Heister, 1700).



FIG. 7.—STEEL CORSET BRACE WITH JURY MAST (De la Croix Skol, 1725).



FIG. 8.—SPINE BRACE WITH JURY MAST (Levascher, 1764).

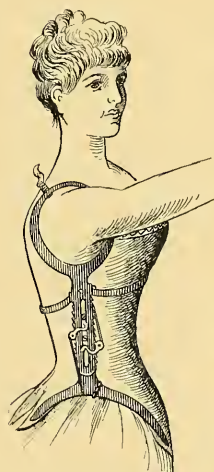


FIG. 9.—SPINE BRACE (Portal, 1767).

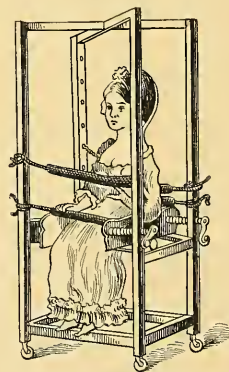


FIG. 10.—CORRECTIVE APPARATUS FOR SPINAL CURVATURE (Levascher, 1768).



FIG. 11.—SUSPENSION APPARATUS FOR LATERAL CURVATURE OR POTT'S DISEASE (Vense, 1788).

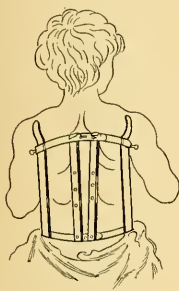


FIG. 12.—SPINE BRACE (Schmidt, 1794).

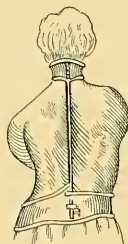


FIG. 13.—COLLAR AND CHIN PIECE (Kohler, 1795).

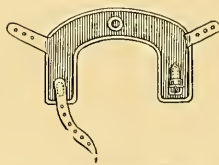


FIG. 14.—SUSPENSION APPARATUS (Glisson, 1799).



FIG. 15.—SUSPENSION AND CORRECTIVE APPARATUS (Darwin, 1801).

been but little modified since his time. In 1806 there appeared a work upon deformities by Jorg. The greatest mechanical genius of this time in Germany was Johann Georg Heine, who established the first German orthopedic institution, upon the plans of which, succeeding institutions of this description have since been based. He perfected the club-foot shoe, modified the extension bed of Venel, and invented several orthopedic appliances.

The first work in which stress was laid upon the importance of mechanics in anatomy, physiology, and treatment was written by Heidenreich in 1824, and at the same time Wenzel contributed his work upon diseases of the spine, and in 1837 Scoutettin published a valuable work upon club-foot. The most important advance of this period in Germany was the perfection of the method of subcutaneous tenotomy of the tendo Achillis, by Stromeyer, 1831.

During this time the influence of the teaching of Peter Henry Ling, 1816, in regard to the use of gymnastics in orthopedics was making itself felt in Germany and France, and for many years the discussion continued as to the relative merits of the dynamic and the gymnastic forms of treatment. On the one side were arrayed Schilling, Werner, Wildberger, and Bühring for mechanical treatment, and upon the other side Ulrich, Nitzsche, and Melliche for gymnastic treatment.

In France subcutaneous tenotomy of the sternomastoid muscle was practised by Dupuytren, 1821, Bouvier, 1836, and J. Guerin, 1837. The treatment of deformities was generally carried out in institutions, and in 1830 there existed no less than ten of these orthopedic establishments in Paris. The discussion as to the dynamic and gymnastic principles in orthopedics was also carried on in France, the emphasis which had been laid upon the value of gymnastic treatment by Andry and Portal being upheld by Lachaise, who condemned the exclusive use of extension beds and objected to their being used except as an adjunct. At this time the Academy of Sciences in Paris offered a prize for the best paper upon the question of the treatment of deformities by means of gymnastics or by the application of mechanical appliances. Three contests were held without any decision being made, and it was not until eight years later that the prize was awarded to Bouvier and J. Guerin. To Delpech, in 1828, the scientific founder of orthopedics, this branch of surgery is indebted for his success in harmonizing the two methods, and preserving the best in each. To him also belongs the credit of having first performed subcutaneous section of the tendo Achillis. This first operation, however, was ineffectual on account of the suppurating of the wound, but the modification of the sub-

cutaneous method by Stromeyer robbed the proceeding of its dangers and rendered it successful. Prior to this time tenotomies were performed by the open method. Delpech showed the advantages of the subcutaneous method, and his suggestions were followed by all the prominent orthopedic surgeons of the time, especially by Duval, Pravaz, Jules Guerin, and Bonnet, and Pirogoff in Russia contributed a valuable monograph upon the histology of tenotomy. Like many other great discoveries in surgery, subcutaneous tenotomy was at first recklessly and extravagantly performed, so that until about sixty years ago orthopedic surgery was a despised and rejected art.

In England the progress of orthopedic surgery was slow, and in 1801 Benjamin Bell criticized the lack of knowledge of orthopedics possessed by the physicians of his day, and declaimed against traveling mechanicians. Perhaps the most important work of the period was that by Harrison, 1820, upon Scoliosis. The necessity for scientific work in this branch was felt by the profession, and in order to encourage investigation the Medical Society of London offered the Hunterian prize, 1822, for the best original work upon the value of mechanical means in the cure of deformities of the vertebral column. The important work of Sir Benjamin Brodie in 1834 upon diseases of the joints was an epoch-making book, and became the standard for all subsequent works upon this subject.

The important discovery of subcutaneous tenotomy was brought into England by Little, a patient and pupil of Stromeyer, and known as the "apostle of tenotomy," who established a Royal Orthopedic Hospital in London in 1837, and in 1853 published a work upon deformities which continued popular until the close of the century, and which may still be consulted with profit. Among the most important studies in England during the first half of the century were the valuable works upon curvatures of the spine by Shaw, Bamfield, Tamplin, and Bishop. All of these may be consulted with profit at the present time by any one interested in the mechanical causes of distortions.

Between the years 1850 and 1870 the progress of orthopedics was slow, notwithstanding the important discovery of anesthesia. In Germany there appeared the distinguished work of the Weber brothers, 1856, upon the "Statics and Mechanics of the Human Body." This furnished a stimulus for the subsequent work of Ludwig, Henke, von Meyer, and Langer. During this period Langenbeck introduced subcutaneous osteotomy, in 1854.

In France there appeared the works of Malgaigne, 1862, and of C. Gaujot and E. Spillman, 1867.

In England Barwell introduced the use of rubber muscles, and there appeared contributions to orthopedic literature from L. J. Chance, who invented a spine brace; Heather Bigg, upon the subject of deformities of the spine; W. Adams, upon club-foot, and by Brodhurst upon ankylosis.

From 1870 to the end of the century orthopedic surgery advanced with rapid strides, partly on account of the discovery of the tubercle bacillus by Koch in 1882 and particularly on account of Lister's great discovery of antiseptic surgery, which made the performance of all operations a much less dangerous proceeding than before, and assured a cure in a great number of cases. Surgery began to be practised in connection with orthopedics much more generally, and was attended by many successful results, when employed in connection with mechanical appliances as an after-treatment. The operation of arthrodesis was first performed during this period by Albert, of Vienna, and also by Wolff in Germany. Open section of the tendons was also revived at this time by Treves, Volkmann, and Lorenz, and Hoffa introduced the open operation for reducing congenital dislocations of the hip. Beely advanced the subject of the treatment of spinal deformities, and invented several appliances and machines.

In France the operation of osteoclasis was practised by Delore, the credit for perfecting a new method of osteoclasis which has since been of great service to the orthopedic surgeon being due to Robin, who with Collin manufactured an osteoclast which enabled the operation to be performed with great success.

In Italy Rizzoli invented an osteoclast and advanced the subject of osteoclasis very materially. Palletta contributed some valuable work in connection with the subject of congenital dislocation of the hip, and there was also at this time Panzeri and Magary, who established the "*Archivio di Ortopedia*" in Milan, 1884, and who advanced the practical treatment of deformities very greatly in their country. Von Motta and Cordivilla also contributed some valuable works upon orthopedics at this period.

In England Bernard Roth has contributed a valuable and extensive work on lateral curvature of the spine, and there have appeared contributions by Little, upon in-knee, Parker, on club-foot, and Edmund Owen, upon surgical diseases of children. Hugh Owen Thomas invented a number of splints, and Robert Jones succeeded him and carried on this work, also contributing several very valuable papers upon orthopedics.

During this period many orthopedic hospitals and institutions were established in London, notably the Royal Orthopedic Hospital.

This last quarter of the nineteenth century witnessed the production of many valuable contributions to the literature of orthopedics. In England there was a very important monograph upon "Spinal Caries" by Heather Bigg, and among the most valuable of the larger treatises were those of Reeves, Tubby, Keetley, and Clarke. In Germany we have those of Schreiber, Hoffa, and Joachimsthal, and in France those of de Saint-Germain, Kirrison, Lannelongue, Redard, and Berger and Banzet.

There were also established in France at this time two principal orthopedic publications, the "*Annales de Chirurgie et Orthopédie*," by Bilhaut, and the "*Revue Orthopédie*," by Kirrison.

AMERICAN HISTORY.

In this country orthopedic surgery has always claimed the attention of the profession and its advances have kept pace with the progress in Europe. From the time of the establishment of medical institutions of learning, in 1763, and for half a century afterward, medical thought and practice were influenced by the schools of Edinburgh, London, and Leyden. After 1820 British influence began to wane; the influence of French teaching began to be experienced, and for thirty years, 1830 to 1860, medical literature and practice were entirely dominated by the Gallic school. The influence of German medicine, which had been steadily growing for a score of years, 1840 to 1860, produced a decided change of allegiance, which continued to the close of the nineteenth century.

At certain periods in the history of this subject trans-Atlantic methods have been remodeled upon cis-Atlantic principles, notably the introduction of the long fracture splint of Physick, and the employment of traction in the so-called "American method" of treating joint disease and deformity (by which title it is known throughout Europe at the present time), by Davis and Taylor, and also the introduction into Europe of plaster-of-Paris jackets by Sayre.

During the first period the great Physick taught English methods, and Dorsey's "Elements," 1813, were largely Hunterian teaching as reflected by his pupil. The third edition of this work, edited by Randolph, was used as a text-book in the University of Edinburgh, the foremost school in the world.

During the second period Barton, 1826, performed the first osteotomy

of the hip, in 1824 Gibson's comprehensive work on surgery appeared, and Gross, in his "Bones and Joints," 1830, recommended the use of adhesive plaster for extension and counter-extension. The great discovery of Stromeyer was brought into this country by Rogers, 1834, Dickson, 1835, and Detwold, 1837; and in 1844 Mutter published a monograph upon club-foot. In 1850 Carnochan published his complete treatise upon "Congenital Dislocation of the Head of the Femur," and in 1852 the first excision of the hip in this country was performed by Bigelow. The greatest genius of this period was Henry G. Davis, who, in 1857, invented the continued elastic extension, the so-called "American method of treating joint disease and deformities," and who also introduced the use of rubber muscles.

The third period was marked by advances in the treatment of diseases of the joints by Hodges, Nott, Markoe, and others, and the treatment of affections of the spine by Ashhurst, Lee, and others. Bauer, 1861, devised a wire breeches for the treatment of hip-joint disease. Prince, in 1866, published his "Plastics and Orthopedics," and C. F. Taylor invented a spine brace and hip splint which are universally employed. The most enthusiastic exponent of the orthopedic art during this period was Lewis A. Sayre, who invented the plaster-of-Paris jacket and extended its use throughout the civilized world. In 1861 the great exponent of conservative orthopedics, Buckminster Brown, established the Samaritan Hospital, in Boston, and in 1863 Knight established the Hospital for Ruptured and Crippled, in New York. The New York Orthopedic Hospital was established by Shaffer in 1871, and the New York State Hospital for Crippled and Deformed in 1900.

The year 1887 marks an important year in the history of orthopedic surgery by the organization of the American Orthopedic Association, among the charter members of which appear such distinguished names as: E. H. Bradford, Buckminster Brown, C. C. Foster, V. P. Gibney, A. B. Judson, Benjamin Lee, R. W. Lovett, Thos. G. Morton, Roswell Park, John Ridlon, A. Sydney Roberts, Lewis H. Sayre, Reginald H. Sayre, Newton M. Shaffer, A. J. Steele, Henry L. Taylor, Ap Morgan Vance, and DeForest Willard.

The contributions of this Association to the literature of orthopedics have been many and valuable, but the recent history of this branch of surgery is so accessible and so voluminous that a detailed account of recent contributions is not within the scope of this work except as it occurs under the head of the various subjects treated in Part II. For a complete bibliography

of the works of the members of the American Orthopedic Association the reader is referred to volume xv of the Transactions of the Association.

Among some of the most important treatises, however, we may here note those of Knight, Sayre, Bradford and Lovett, Young, Whitman, McCurdy, and Judson. Important monographs on diseases of the hip have been contributed by Gibney, Lovett, and Allis, and on joint diseases by Ridlon and Jones.

The establishment of the "American Journal of Orthopedic Surgery," under the auspices of the American Orthopedic Association, marks one of the most important advances in the recent literature of this most important branch of surgery.

CHAPTER II.

GENERAL ETIOLOGY AND PATHOLOGY OF DEFORMITY.

In considering the subject of etiology it is best to make two divisions, congenital and acquired.

CONGENITAL DEFORMITY.

The study of the causes of congenital deformity reveals much that is obscure and unexplained. These deformities may be considered under two groups—those which are due to primary change occurring in the ovum, or during the development of the fetus, and those which occur to the fetus after it has been properly formed. The former are malformations, and as teratogenic conditions are of more especial interest to the teratologist and obstetrician, only a few subjects surviving with spina bifida, hare-lip, etc. The latter are true deformities and may occur from influences acting upon the healthy fetus or influences upon a fetus which is diseased. The different theories which have been advanced to account for deformity include the theory of heredity, the theory of intrauterine pressure or traumatism, the theory of pre-natal disease, and the theory of arrest or defect of development.

Heredity.—The effect of heredity upon the production of certain deformities has long been recognized. Thus, we have club-foot, congenital dislocations, certain nervous affections, as progressive muscular atrophy, and occasionally lateral curvature. The hereditary affection may occur through one or both of the parents, and this is particularly true of consanguineous marriages.

Intrauterine Pressure or Traumatism.—That deformities may result from intrauterine pressure or traumatism has long been recognized by both the profession and the laity. The exact manner in which the deformity is produced has been disputed and still remains unsettled. That it may be the result of a fall, a blow, or undue compression is proved by the experimental studies which have of late been undertaken, and by the deformities which appear to have followed directly upon direct violence. Dareste, Pan-nin, Warynski, Foe, and Lombardine have made some interesting experi-

ments with chickens' eggs, varnishing them during the incubation time, raising and lowering the temperature, injecting substances into them, etc., thus producing various monstrosities and absences of parts in the chickens. While the deformity may be produced by direct compression, it is more frequently the result of the interference occurring from the compression upon the normal development of the part. Thus, in club-foot the compression interferes with the normal rotation outward of the tibia, and in this manner prevents proper development.

In this connection the effect of maternal impressions as a factor in producing deformities should be considered. In exceptional instances the deformities resemble some object which through shock or fright has made an impression upon the mother, but can usually be accounted for in some other

way, or the fright has occurred at a period of the pregnancy when the effect on the fetus could not have been so pronounced.

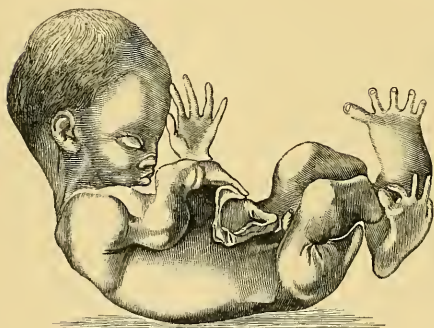


FIG. 16.—INTRAUTERINE RICKETS (Ballantyne).

The effect of maternal impression in the production of club-foot, the one most frequently attributed to this cause, has been found not to have been a real factor in a single instance, and in general the effect of maternal impressions is so slight that it may be disregarded.

Pre-natal Disease.—The effect of pre-natal disease in producing deformity cannot be denied, since lesions similar to those occurring in the pre-natal period, especially rickets and lesions of the central nervous system, are not infrequently found to exist in the post-natal period. The association of extensive nervous lesions, such as spina bifida, anencephalus, or hydrocephalus, has seemed to confirm this theory, but club-foot is not always present.

Arrest or Defect of Development.—The theory of arrest of development, or the osseous theory, is a very popular one at the present time, confirmed as it is by such deformities as spina bifida, cleft palate, and hypospadias. This theory has been rendered more popular by the so-called archio-

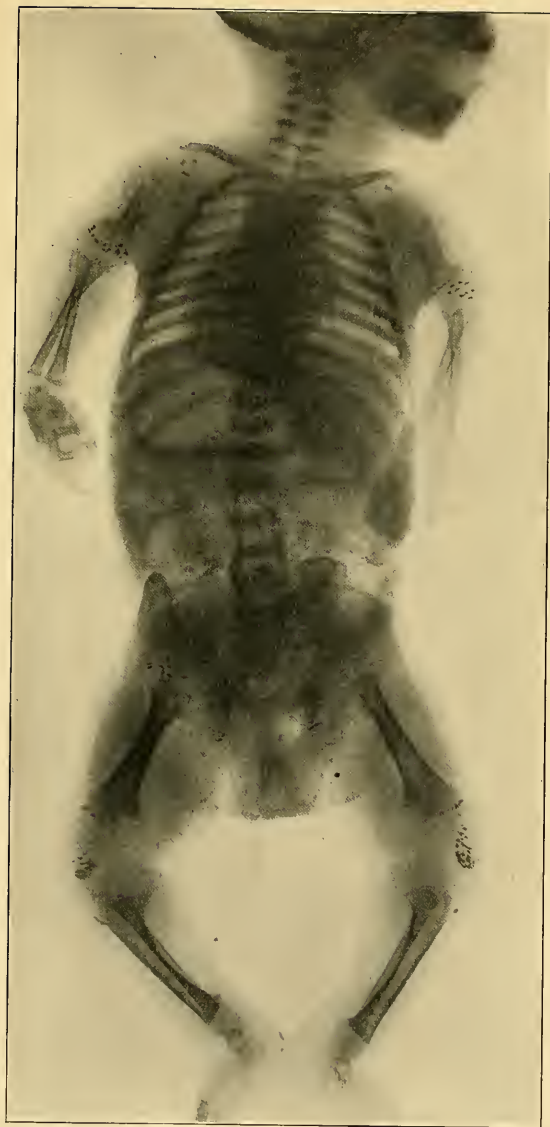


FIG. 17.—ARREST OF GROWTH FROM DEPOSIT OF BONE.

tergium or ray theory. This theory, which describes the histologic development upon the rays from a common center diverging in different directions, seems to be supported in instances of some deformities by reason of the absence of all the parts included within certain radii. In the most important deformities ascribed to this cause there is the congenital absence of bony parts. Another, the amniotic theory, also sufficiently explains the production of most of these deformities, so that the theory of arrest of development is not so important as at first appeared.

The occurrence of deformity resulting from primary changes in the bones, such as in the astragalus or the os calcis in club-foot, cannot be denied, but there is still much difference of opinion in regard to the deformities of these parts as to whether they are causative or the result of pressure. The arrest of growth where the parts are perfectly formed is most difficult to explain. It might be due to partial cutting-off of blood-supply—*ischemia*. In some instances it is due to disease and too early deposit of bone in the epiphyses, arresting the growth.

The subject of congenital deformities will be considered more fully in taking up each individual affection under its own heading.

ACQUIRED DEFORMITIES.

By far the larger number of deformities are acquired as the result of traumatism, faulty attitudes (static or habitual), constitutional causes, and deformities secondary to inflammatory disease.

Traumatic Deformities.—The deformities due to traumatism usually occur from fractures or dislocations of the bones. Deformity from a fracture may be produced by a faulty union of the part, changing the relations of the adjacent structures, or it may be due to an interference with the growth of the part. This is particularly true where the injury involves the epiphysis. In some cases the bone increases in length from irritation of the epiphysis, and in others it remains undeveloped from destruction of the epiphysis, the deformity resulting from the adjoining bones. Thus, we have deformity in the hand resulting from injury to the radius, or deformity of the foot from injury to the fibula.

When luxations occur, the deformity is produced by the changed position of the parts, and also from the changes which occur in the structure of the articular surfaces from the alteration in the function.

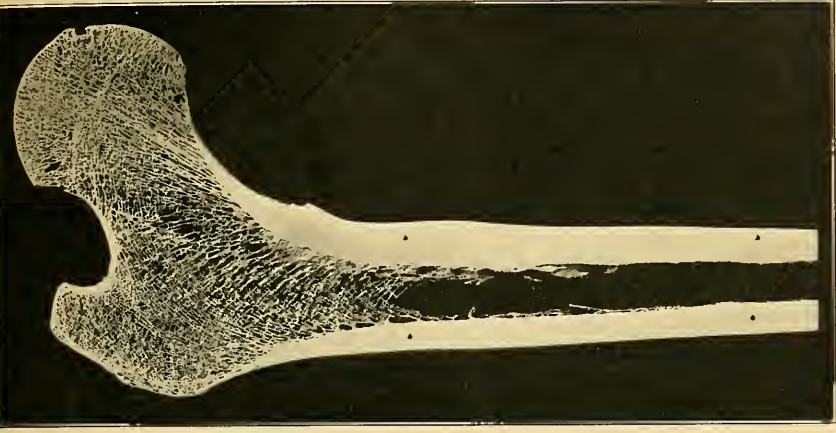
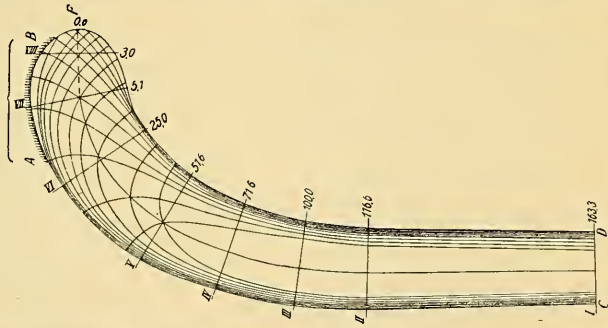
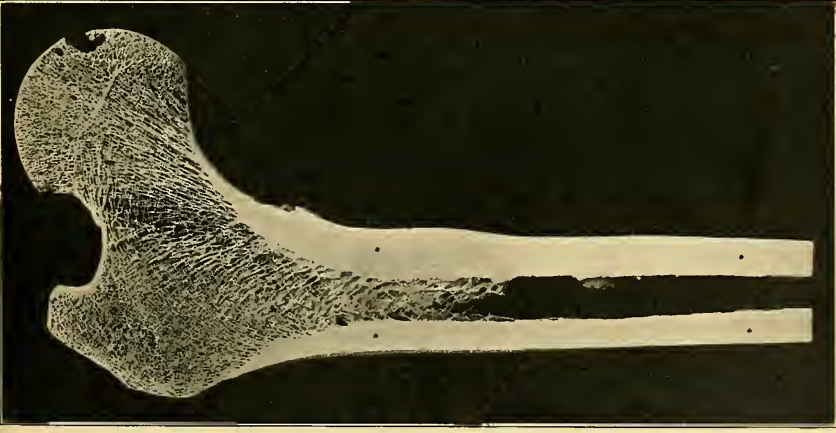
Static or Habitual Deformities.—There has been some difference of

opinion as to the origin of this variety of deformities, as to whether it is due to cause or to effect.

For many years the theory known as the Volkmann-Huetter theory has been the one generally accepted. This theory asserts that on account of muscular weakness a faulty attitude is assumed, and deformity follows by reason of the greater pressure which is made upon one side, while the other side is subjected to a pressure less than normal, as in genu valgum the outer side of the joint bears the greater weight, while the inner side bears a sub-normal weight. By the theory that under normal conditions the development depends upon the intra-articular pressure the deduction is made that any increased pressure on the concave side would interfere with the normal development of the bone, and even cause atrophy of the bone already formed, while the lessening of the normal pressure upon the internal side would cause an excess of growth on that side. This theory, known as the "pressure" or "superincumbent weight" theory, has been upheld by Roser, Lorenz, Hoffa, Schreiber, Redard, Judson, Bradford, and Whitman.

In contradistinction to this theory we have that advanced by Julius Wolff, 1892, and known as "Wolff's law." After a careful study of the correspondence between the structure of bone in normal and abnormal conditions, combined with certain calculations of graphic statics, he deduced a theory of the "functional pathogenesis" of deformity. This he calls the "law of transformation," and states that he believes it to have its strongest confirmation in the striking resemblance to be found between the internal architecture of the normal femur and the grapho-static diagram of a Fairbairn crane, as drawn by the mathematician Culmann. The outline of this crane, bearing a load of 30 kilograms, which is approximately the average weight borne by the normal adult femur, shows a remarkable analogy to that of the human femur, without the trochanter major. Von Meyer has called attention to this analogy between the courses of the bone trabeculae in the human femur and the trajectories of the crane in Culmann's drawing. While developing his theory Wolff asserted that the similarity between the spongiosa in the sagittal section of the femur and the "neutral plane" of Culmann's drawing was in accordance with the requirements of the grapho-static figure, which assertion he confirmed later on by anatomic proof.

Upon the completion of his study upon the subject Wolff resolved his



theory into the following proposition: "Every change in the form and function of the bones, or of their function alone, is followed by certain definite changes in their internal architecture, and equally definite secondary alterations of their external conformation, in accordance with mathematical laws."



FIG. 21.—DEFORMITY FOLLOWING FRACTURE OF FEMUR (Wister Institute of Anatomy).

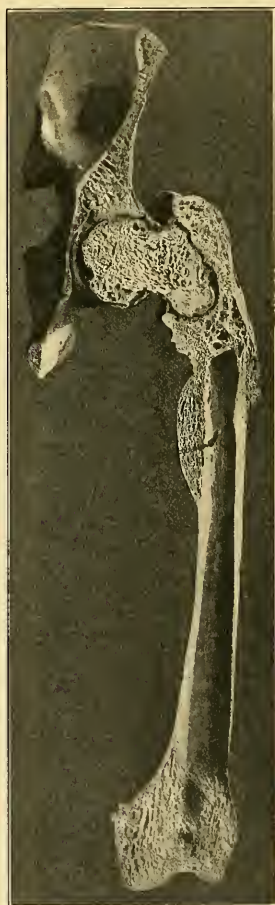


FIG. 22.—COXA VARA FOLLOWING FRACTURE OF NECK OF FEMUR (Philadelphia College of Physicians).

Up to the present time this "law" has not been generally accepted, although its probability, along certain lines, has been recognized. The chief

reason for its non-acceptance is the impossibility of substantiating it by mathematical proof. This would be an exceedingly difficult task, as it is almost impossible to compute with mathematical exactness the physical characteristics of the bones, and the complex problem of the construction of the femur and the amount of muscular stress devolving upon it. This is especially true since the great trochanter is left out of the calculation entirely, whereas it is always present and is an important factor in the amount of



FIG. 23.—CONGENITAL ABSENCE OF FEMUR (Jones).

muscular stress borne by the femur.

Wolff himself said: "I also concede that the conditions in the live organism are much more complicated than they can appear in the mere observation of Culmann's drawing. Many anatomic and mathematical researches will be necessary to complete our knowledge in this direction."

That there is fundamental truth in Wolff's law is proved in cases of mal-union of the fractured humerus, where superincumbent weight would not be a factor, or in a case of severe congenital talipes equino-varus, noted by Wolff, where the child had never walked. He states in mentioning this case that the bone transformation constitutes the deformity and that function is consequent upon this transformation. In cases of incipient

scoliosis where the bones are not involved this law would not apply, and the theory of superincumbent weight would be more probable.

That function alone is the cause of deformity is largely open to question. Wolff, in writing upon the pathology, asserts that both the internal architecture and the configuration are changed, as well as the external conformation; that the deformity is due entirely to the functional changes in the bone; and that "the shape of the bones and joints of the deformed parts represents nothing else than the functional accommodation to the faulty

static demands made upon it." This statement would appear to include, under the head of "static demands," what has been generally known as faulty or unavoidable attitudes assumed by patients, these being the fundamental cause of the deformity, which is augmented by the functional transformation of the bones.

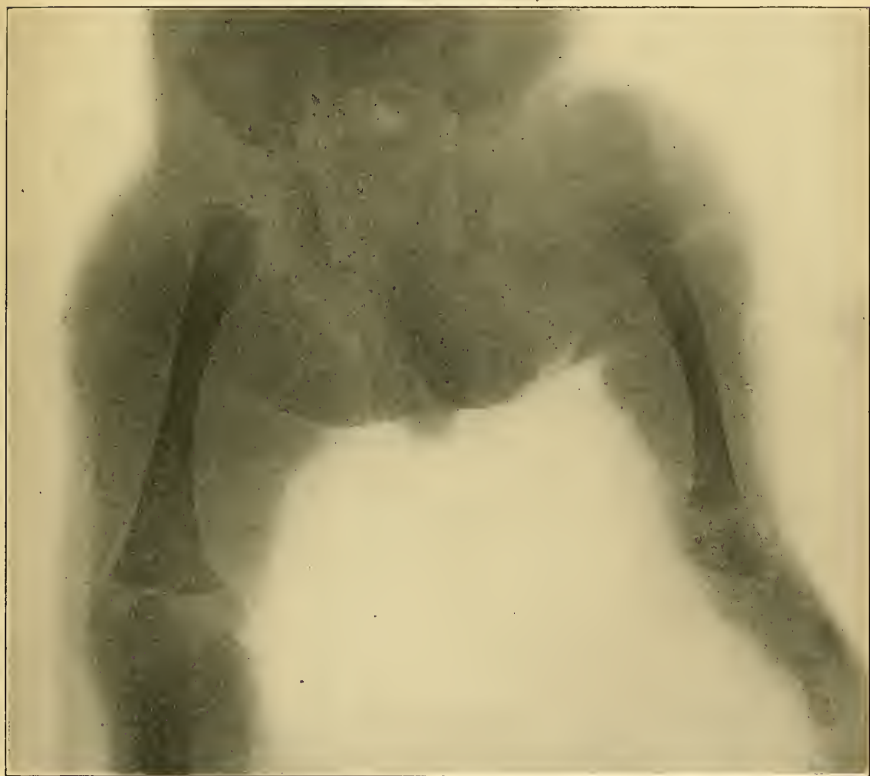


FIG. 24.—CONGENITAL ABSENCE OF FEMUR. X-RAY (Jones).

From a therapeutic standpoint Wolff's law is of value in emphasizing the importance of over-correction in genu valgum and genu varum and in scoliosis. It has also been of service in the correction of conditions such as coxa vara, as it has thrown much light upon the static demands of these conditions.

In this variety of deformity, whether produced by cause, superincumbent weight, or by effect, as the result of functional changes, there are certain characteristic alterations in the parts upon which the weight or "burden-bearing" devolves. These alterations are called by the general term of atrophy by the upholders of the theory of superincumbent weight. Atrophy, in its actual sense, however, cannot be said to occur, as may be seen by a study of sections of diseased bones, but there is always present a lessening, or osteosclerosis, on the concave

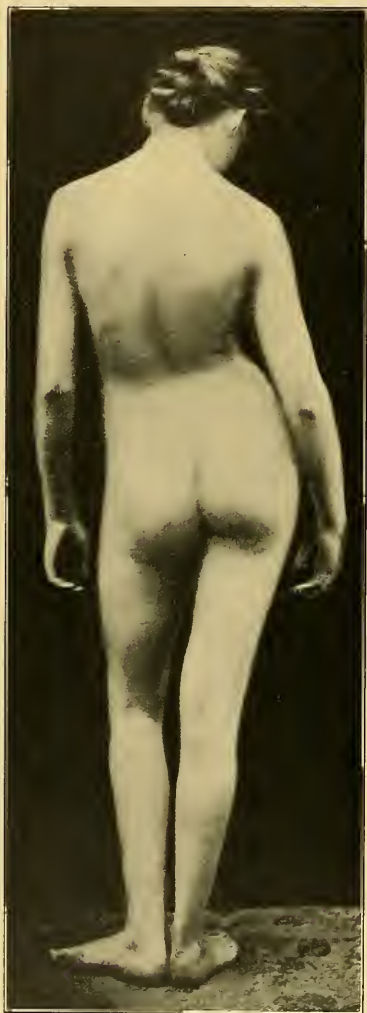


FIG. 25.—FAULTY ATTITUDE (Artist's Model).



FIG. 26.—LATERAL CURVATURE FROM ABSENT TIBIA (Erich).

side of the deformity, and a thickening, or osteoporosis, on the convex side.

In regard to the production of deformity from faulty attitudes, it has now become an established fact that scoliosis is, as a general rule, due to this

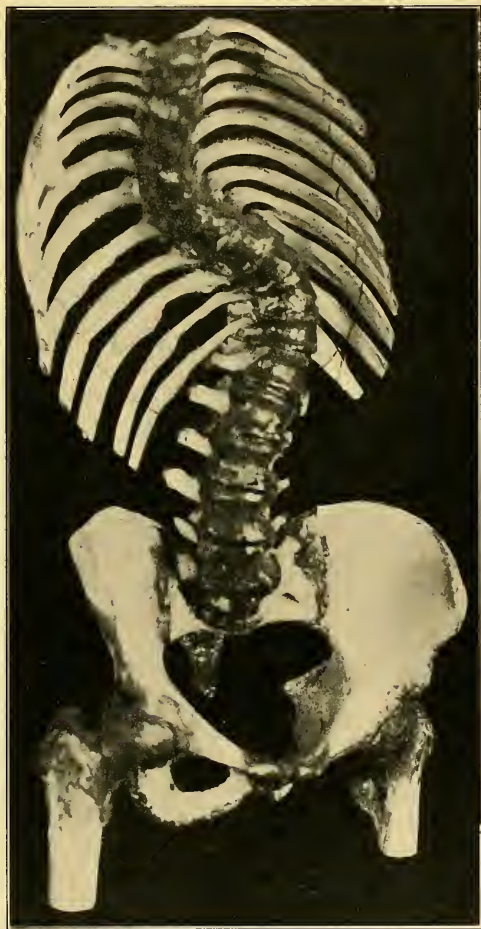


FIG. 27.—LATERAL CURVATURE. BONY SPECIMEN (Philadelphia College of Physicians).

cause, and the manner in which it is produced is interesting. As the result of fatigue an attitude of rest, with the weight of the body thrown entirely

upon one side, is assumed by children. This produces an elongation and relaxation of the extended limb, while the limb upon which the weight rests remains normal or slightly over-developed. When the child assumes the correct position, the increased length in the extended limb causes a tilting of the pelvis, with curvature of the lumbar vertebrae toward the short limb, and later a compensatory curve in the dorsal region.

The occurrence of flat-foot from faulty positions is the result of the



FIG. 28.—RACHITIC KNOCK-KNEE.



FIG. 29.—RACHITIC KNOCK-KNEE. BONY SPECIMEN
(Philadelphia College of Physicians).

breaking-down of the plantar ligaments and fascias from the continued pressure of the superincumbent weight. The production of rachitic deformities about the knee-joint due to superincumbent weight varies with the manner in which the weight falls upon the part. If the limbs are widely separated, the resulting deformity will be a bow-leg. If the knees are close

together or if one knee only is inclined inward, the resulting deformity will be knock-knee, single or bilateral. The deformity at the knee-joint in rickets is frequently produced by the pressure of the arm of the mother



FIG. 30.—SCOLIOSIS PRODUCED BY FAULTY MANNER OF CARRYING CHILD.

in carrying the child, the deformity in unilateral rachitic genu valgum being always on the side pressed by the arm upon which the child is supported.

Vestmentary Deformities.—In this connection the deformities produced

by pressure other than superincumbent weight should be considered. These deformities are sometimes spoken of as "vestmentary deformities," since they are produced by the pressure of the clothing, shoes, etc. The deformities produced by pressure from the use of corsets are not so common at the present time as formerly, since the practice of wearing corsets has been abandoned by many persons, and the faulty construction of the corset has been largely overcome. The injurious effects of corset pressure are seen in the unsightly deposit of adipose about the hips and upper thigh, and in the atrophy of the subcutaneous tissue and the rectus abdominis and longissimus dorsi muscles about the waist line. Too much credit cannot be given to the gifted writer of "*Gates Ajar*," and her contemporaries, for the influence which they have exerted upon the philosophy of clothing and the manner in which they have emancipated women "from corsets that embrace the waist with a tighter and steadier grip than any lover's arm, and skirts that weight the hips with heavier than maternal burdens."

There is still a field partially unoccupied which deals with the defective dressing of children, and Noble Smith, Bradford, and others have added the weight of their influence in the endeavor to remedy this evil.

Deformities produced by faulty clothing in growing children are evidenced in the drooping head, round shoulders, hollow back, and weak walk of the present generation. If one compares the French statue of today with the ideals beheld in the statues of the past, the contrast is striking. Instead of the full neck, high chest, shapely arms and shoulders, the vigorous trunk, and erect and noble carriage of the Venuses and Junos, Helens and Madonnas, we behold a vision of long necks, angular shoulders, of sunken chests, bulging hips, and lean legs, as in the "*Prima Vera*."

The last decade has witnessed great improvement in the physique of the American maiden through increased devotion to out-of-door sports, and today the vestmental deformities are in many instances largely overcome, and the luxuriant form, damask cheek, and brilliant eye denote an American product the peers of their hardy trans-Atlantic cousins.

Still another comparison can be made by the study of the human form among aborigines untrammelled by clothing. Even here, however, the heavy neck ornaments produce deformity, and most half-clothed natives show slight pressure signs, produced by the compression of the cestus, or band about the waist.

The evil effects of faulty footwear can best be understood by a



FIG. 31.—TORSO OF VENUS, NAPLES.



FIG. 32.—PRIMA VERA (Botticelli).



FIG. 33.—VENUS CNIDUS (Praxiteles).



FIG. 34.—VENUS GENETRICE, FLORENCE.



FIG. 35.—HERMES OF PRAXITELES.

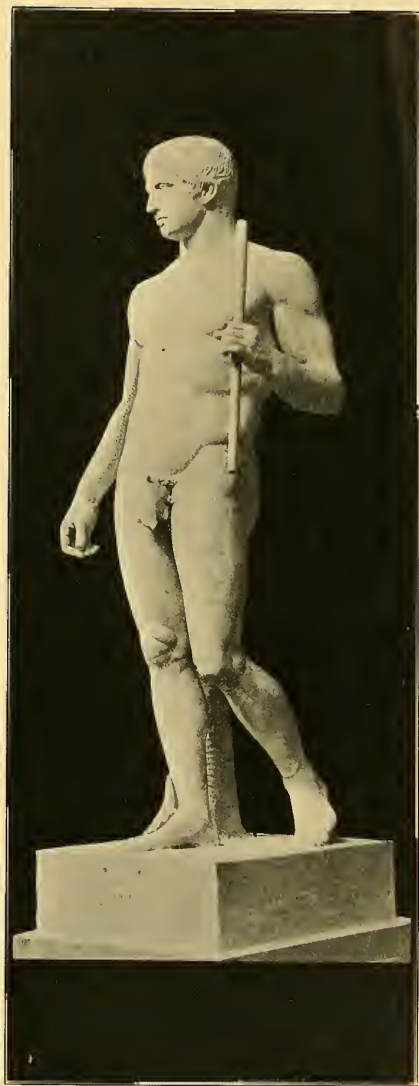


FIG. 36.—GLADIATOR.

comparison of the shoe-bound foot of today with the ideal represented by the famous foot in the *Hermes of Praxiteles*. In this the inner edge is straight, the outer edge is but slightly curved, the little toe is neither crumpled nor twisted and lies parallel to its fellows. Compression of the foot in front is the most common deformity, the *hallux valgus* resulting from the crowding outward of the end of the great toe, and the curling downward and inward of the little toe from lateral pressure made by a too narrow shoe. The latter deformity, at first from the pressure of the cross-thong and later from the crowding of the shoe, has been universally represented in art since the sixth century B. C., as seen in the *Gladiator* and other famous statues, and investigation of large collections of shoes, such as the one at the Chicago World's Fair, or the one at the *Musée Cluny* in Paris, demonstrates the fact that deformities of the feet were as common during the Dark Ages as they are today. In addition to *hallux valgus*, among the most common deformities are *hammer-toe*, *overlapping toe*, *weakened foot*, *flat-foot*, injury to the transverse arch, and *crumpled toe*.

Since foot deformities occur very early during adolescence it is exceedingly difficult to find a normal foot among civilized people; and when found it will usually be discovered that the possessor has not worn shoes during this period.

A classic example of the effect of pressure in producing deformities of the feet is seen in the ingenious devices for bandaging and deforming the feet of Chinese women.

Constitutional Deformities.—Constitutional diseases are responsible for a great number of deformities, the most important of which are tuberculosis, rickets, osteomalacia, osteitis and arthritis deformans, and the osteo-arthropathies of spinal origin.

Tuberculosis bears so important a relation to the production of deformities that an entire section will be devoted to it.

The deformities produced by rickets include lateral curvature, pigeon breast, coxa vara, knock-knee, bow-legs, and the curvatures of the diaphysis. The mechanism of the production of rachitic deformities is well understood. During the second stage of bone softening the superincumbent weight deforms the bones, and they retain this deformed shape after they have become consolidated and hardened during the third stage. The production of late rickets, or *rachitis tarda*, is not so well understood, but it is probably due to causes similar to those which produce infantile rickets—faulty nutrition.

The marked deformities which are produced by osteomalacia are the result of pressure and faulty positions assumed by the individual during the stage of bone softening. The etiology of this affection is not sufficiently well understood, but with careful observation two forms may be recognized—the infantile and the senile forms. The infantile variety is exceedingly rare, but a sufficient number of cases have been described to identify the affection, and the one here presented illustrates the fact that, while the disease is very crippling in its effect, it does not interfere with life. The changes occurring in the osseous system, such as osteoporosis and universal hyperostosis, atrophy, etc., have their influence upon the production of deformities. Universal hy-



FIG. 37.—OSTEOMALACIA INFANTILIS.

perostosis is the most rare of all the affections of the bones, and the specimen shown in Fig. 39 was taken from a lad of eighteen suffering from hyperostosis combined with osteoporosis.

The lesions in osteitis and arthritis deformans are so universal and so frequent that they are very well understood, and the manner in which they deform the joints is easily seen. The changes which occur in the synovial membrane involve the cartilages and the joints become locked in splint-like osteophytes or undergo an atrophy. In some instances the softening of the bone permits of a change in the angle of the femur, producing a senile coxa



FIG. 38.—OSTEOMALACIA X-RAY. RIGHT ARM.



FIG. 39.—UNIVERSAL HYPEROSTOSIS WITH OSTEOPOROSIS (Philadelphia College of Physicians).



FIG. 40.—RHEUMATOID ARTHRITIS (Philadelphia College of Physicians).

vara, while in others the changes in the joints from the overgrowth of the condyle produce a change in the angle of the entire joint, as in the elbow-joint and knee-joint.

The neuropathic lesions of spinal origin, from tabes or syringomyelia and other causes, constitute a large group of affections which are instrumental in producing deformities. The deformities due to cerebral palsies of the hemiplegic, diplegic, and paraplegic types constitute an important group of

affections. Those deformities produced by the primary myopathies are included in the comprehensive term of "muscular dystrophy," and present a large group of wast-



FIG. 41.—OSTEITIS DEFORMANS SYPHILITICA.



FIG. 42.—GENU RECURVATUM
(Joachimsthal).

ing diseases, such as simple muscular atrophy, pseudo-hypertrophic paralysis, progressive muscular atrophy, etc. Multiple exostoses occurring in children present another interesting group, and the resulting deformities are being carefully investigated at the present time. The production of deformities by osteomyelitis through the rarefaction of the bones deserves notice, since it gives rise at times to serious deformity of the joints. An excellent example of this is seen in the contracture of the knee-joint from overgrowth of the femur.

Trauma as an Etiologic Factor.—The influence of trauma as a causative factor in the production of non-tuberculous joint disease is supported by statistical evidence and clinical observation. Various joint lesions are localized by slight injury, as sprains and contusions, while their absence is frequently noted after fracture. They are more apt to follow slight injuries than those of a more severe character. Many infectious processes, such as an acute osteomyelitis, gonorrheal arthritis, and syphilitic



FIG. 43.—ATAXIC JOINT.



FIG. 44.—DEFORMITY OF KNEE-JOINT FROM OSTEOMYELITIS (Hoffa).

periosteitis, are localized by traumatism. Patients who are subject to attacks of acute articular rheumatism are very apt to develop a very severe attack and recover more slowly after they have sustained a moderate injury to the joint. While it is impossible to see what relation injury bears in the development of or in aggravating the arthropathies of the nervous system, yet it frequently happens that such an attack is first ascribed to injury, and if the condition becomes



FIG. 45.—PROGRESSIVE MUSCULAR ATROPHY.

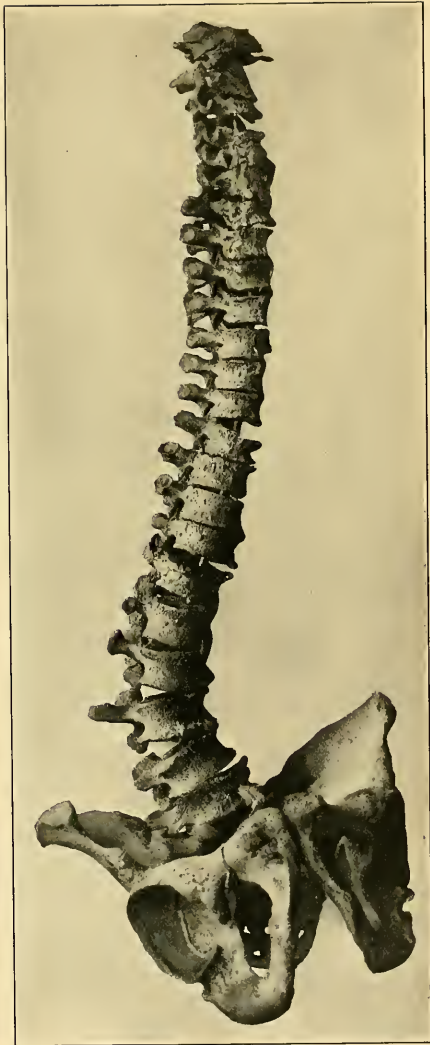


FIG. 46.—EXOSTOSES OF VERTEBRA AND ILIA (Philadelphia College of Physicians).

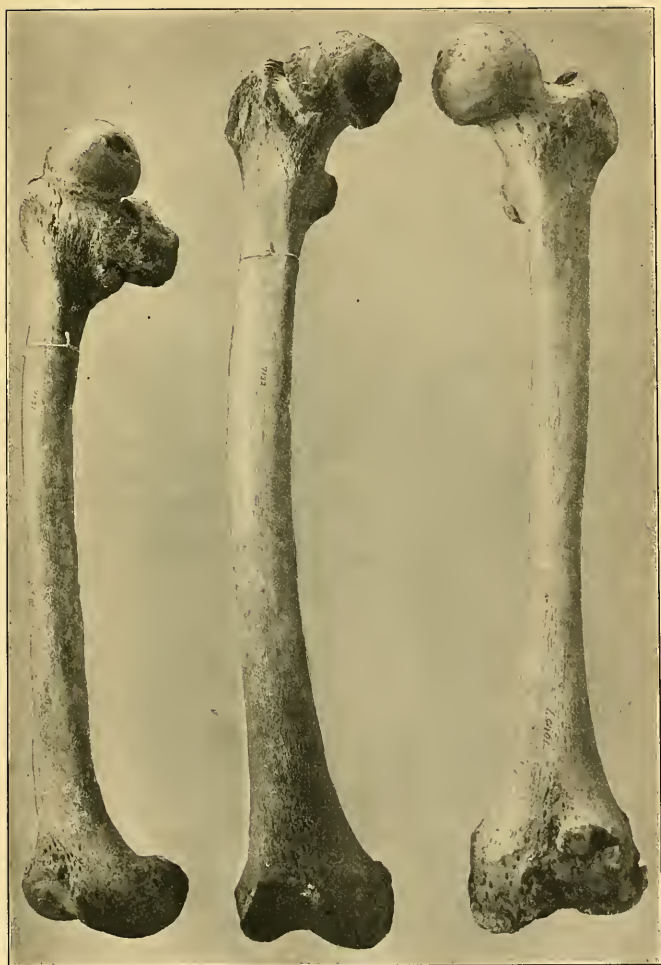


FIG. 47.—EXOSTOSES OF FEMUR (Philadelphia College of Physicians).

worse, it is usually referable to some previous trauma. The neuro-pathologic condition found in hysteric joints and various neuroses following trauma is not well understood at present. The symptoms present in these cases are

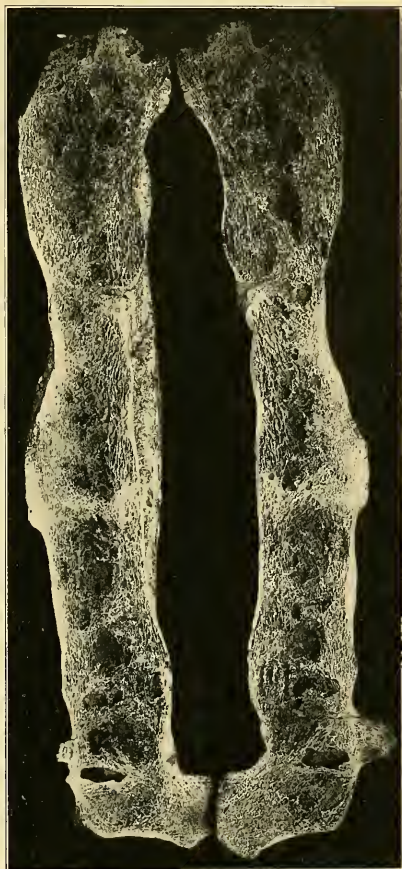


FIG. 48.—INFECTIVE OSTEOMYELITIS (Philadelphia College of Physicians).

entirely out of proportion to the extent of the injury, and at first lead one to consider that some grave lesion is present.

Contractures and Ankylosis.—A large number of deformities are pro-

duced by contractures, and there are different ways of subdividing this variety of deformities. It has been divided in the same manner as that of the general classification of deformities, under the head of traumatic, static, constitutional, and inflammatory; but the best classification is that of Hoffa, which divides them into five groups—contractures of the skin, contractures of the fascias and tendons, contractures of the muscles, contractures from nervous lesions, and joint contractures.

The most common cause of contracture of the skin is from extensive scalds, burns, or lacerated wounds. The cicatricial contraction which always follows these lesions produces severe contractures of the adjoining parts. Thus, we have contractures of the fingers, wry-neck, club-foot, and contractures about the larger joints. When the burns or scalds are of the third degree, involving the fascias and tendons, we have some severe contractions resulting. In certain conditions, as Dupuytren's contraction, chronic rheumatism in some forms, and in skin diseases, we have contractures of the fascias. Under the head of contractures of the tendons should be considered the contractions which occur from the inflammatory conditions, such as tenositis and tenosynovitis.

The contractures which occur from muscular action are of two varieties, the passive and the active. Those which are passive include cases which are due to the contraction of one group of muscles, the other muscles being stretched, as in club-foot. The symptomatic forms are the result of rheumatism and general inflammatory conditions. In contractures from rheumatism the muscles principally involved are the pectoralis major, latissimus dorsi, deltoid, occipitofrontalis, trapezius, and the intercostals and quadratus lumborum. We also have muscular contractions from the interference with the articular circulation from pressure of bandages or from disease of the vessels. The occurrence of syphilitic gummas in the muscles, particularly in the sternomastoid or biceps, leads to contraction of these structures, and psoas contraction frequently occurs from a rupture of the fibers with cicatricial contraction, following abscess.

The muscular structure is subject to several different inflammatory processes which result in contractures. Thus, we have a primary form of poliomyelitis which is sometimes combined with polyneuritis and is known as neuromyositis. The degenerative conditions which occur in the fibers frequently cause a condition known as myositis fibrosa, or true bony structure may be deposited in the muscles, a condition known as myositis ossificans.



FIG. 49.—MUSCULAR CONTRACTION FROM OSTEOSARCOMA OF THE VERTEBRAS.



FIG. 50.—X-RAY OF SAME CASE.



FIG. 51.—ANKYLOSIS OF KNEE-JOINT.

Other diseases of the muscles resulting in contractures include abscesses from hematomas or metastatic abscesses from pyemia, the inflammatory changes resulting from tuberculosis, actinomycosis, scarlatina, gonorrhea, and trichinosis.

The contractures which occur from nerve lesions may be reflex, paralytic, or spastic. The reflex contractures usually result from joint diseases, such as tuberculosis, chronic rheumatism, and neuropathies. The paralytic contractures are the result of lesions to the central or peripheral nervous system throughout its entire extent. Lesions of the brain, encephalitis, from apoplexy and tuberculosis, or from tumors, frequently have contracture of parts associated with them. All the degenerative cord lesions also have contractures associated with them. The contractures from poliomyelitis result from three factors—the opposition of the normal muscles to the



FIG. 52.—ANKYLOSIS OF ELBOW FROM EXCESSIVE CALLUS (Jones).

paralyzed muscles, the stretching of the paralyzed muscles from the weight of the part, and the growth of the bones and joints, the paralyzed muscles remaining unchanged. A very frequent source of contracture is injury to the spinal cord from traumatism; the meninges may be torn, giving rise to minute punctate hemorrhages or to extensive extravasations of blood—hemorrhachis. These often remain long after the injury caused by the contracture or dislocation has disappeared, and they sometimes persist after all pressure has been removed by laminectomy. Contractures from spinal meningitis, either infective or resulting from tubercular caries in its late stage, or from pressure of tumors, as osteosarcoma of the vertebrae, are frequently very persistent. The lesions of the peripheral nervous system, such as neuritis or pressure palsies, progressive nerve atrophy, hysteric paralysis, and paralyzes following erysipelas or lead poisoning, are all fruitful sources of contractures. The contractures of a spastic character which occur from cere-

bral lesions include three different principal groups, according to their distribution, in the order of their frequency—the hemiplegic, the diplegic, and the paraplegic. In addition to the paralysis in these cases we have a fourth group—a condition in which a spasmodic character is added to the contracture, and known as athetosis.

The joint contractures are the result of lesions to the soft structures about the joints, the fascias, capsule, and synovial membrane. The involvement of these structures is usually secondary to disease of the bones, or they may be infected by injuries which are not of sufficient severity to involve the bones. They may also be affected by inflammatory processes, infective usually, such as gonorrhea, suppurative synovitis, rheumatism, and acute polyarthritis.

Ankylosis.—The deformities resulting from ankylosis are very common sequels of the various joint lesions. Of these, two forms are recognized—the false and the true. In false ankylosis the soft structures only are involved and the union is not complete, while in the true the articulating bones are closely united. In false ankylosis the part is usually deformed in flexion or with the limb in a position of adduction and pronation. In true ankylosis the joint surfaces are firmly united by fibrous tissue or by bony tissue or sometimes by osteophytes, in some instances the bony structure being continuous between the articulating surfaces. This condition is known as ankylosis fibrosa, ankylosis ossia, synostose, syndesmose, etc. The causes of true ankylosis are tuberculosis and other chronic destructive inflammatory processes. Tuberculosis of the joints is a frequent source of ankylosis. In some instances it



FIG. 53.—ANKYLOSIS OF ANKLE JOINT FROM OSTEOMYELITIS (Philadelphia College of Physicians).

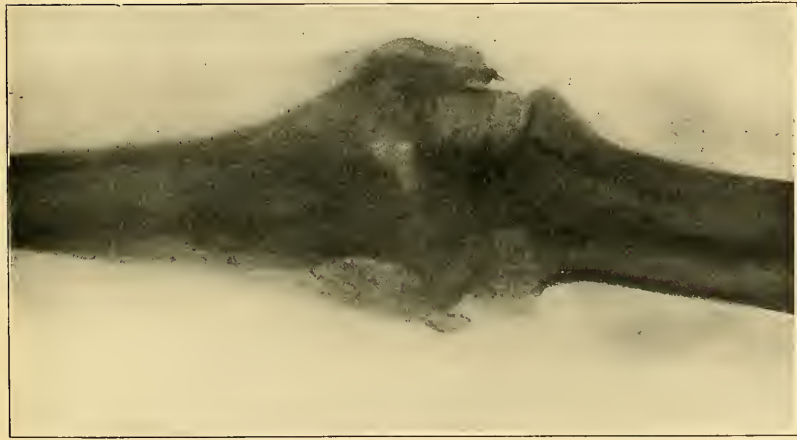


FIG. 54.—ANKYLOSIS FROM EXCESSIVE CALLUS. X-RAY.
ANTERO-POSTERIOR VIEW (Jones).



FIG. 55.—ANKYLOSIS FROM EXCESSIVE CALLUS. X-RAY. LATERAL
VIEW (Jones).

results in true bony ankylosis from the deposit of osteophytes and the union of the eroded surfaces of the bone. In other instances false

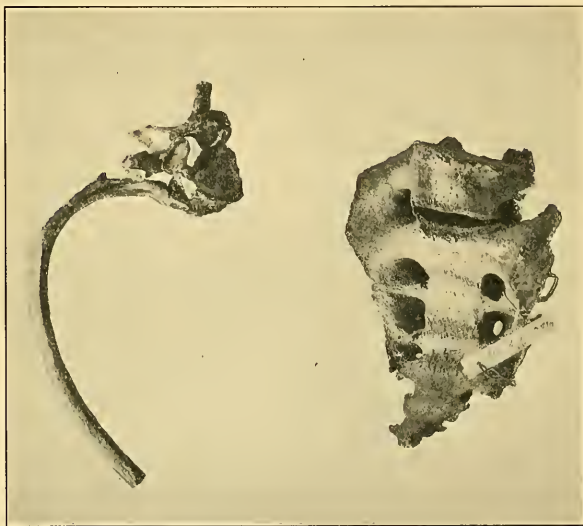


FIG. 56.—ANKYLOSIS OF RIB AND VERTEBRA (Wistar Institute of Anatomy).

FIG. 57.—ANKYLOSIS OF VERTEBRA AND SACRUM (Wistar Institute of Anatomy).

ankylosis results, the bony surfaces not being sufficiently eroded to produce true ankylosis, but the deposit of fibrous tissue being excessive.

GENERAL ETIOLOGY, PATHOLOGY, AND TREATMENT OF TUBERCULOUS JOINT DISEASE.

TUBERCULOUS JOINT DISEASE.

Synonyms.—*English*, strumous joint disease; scrofulous joint disease; fungous joint disease; tuberculous ostitis; tuberculous osteomyelitis; tuberculous disease of joints; white swelling; tuberculous arthritis. *German*, scrofulöse Gelenkentzündung; scrofulöse caries; tuberculöse caries; Gelenk-tuberculose; fungöse arthritis. *French*, ostéo-périostite tuberculeuse chronique; tubercule tardif à évolution rapide; tuberculose chronique; tuberculose articulaire. *Italian*, caries mollis sive fungosa; caries sicca; fungus articuli.

Etiology.—The etiologic factor of tuberculous joint disease was first

definitely ascertained through the discovery of the presence of the tubercle bacillus in chronic diseases of the joints by Koch in 1882. He proved conclusively that the same agent was at work in the production of the pathologic changes found in chronic joint disease as caused tuberculous lesions in other parts of the body. The similarity between certain forms of chronic joint disease and "tubercular" lesions of other parts was first suggested by Rokitsanski in 1844. Virchow considered that the joint lesions were due to miliary tubercles affecting the synovial membrane, and Volkmann pointed out small tubercles in the synovial membrane. Hüter and Schüller experimentally produced tuberculous lesions of joints in animals after inoculation and local injury.

Causes Predisposing to Tuberculous Joint Lesions.—The large proportion of cases having tuberculous joint lesions is due to certain causes which favor the growth of the tubercle bacilli about the joints. These factors may be divided into general and local causes. The general predisposing causes may be considered as *inherited* and *acquired*.

Inherited Predisposition.—That there exists among certain races a tendency to the occurrence of tuberculosis is well known. This is especially shown in the colored race. Children of tuberculous parents are very prone to develop a similar condition either of a visceral or an arthritic variety. It has long been a debatable question as to whether direct infection can occur before birth. Many authorities claim that congenital tuberculosis does not exist. This, however, has been disproved by the demonstrations of tuberculous hip-joint disease in the fetus and newborn by Morel-Lavallé, Marjolin, and Leon Labbé (Hoffa).

That heredity plays a very important part in predisposing to tuberculous joint disease has long been admitted. Statistics on the subject are numerous, and while it is impossible to have any uniformity in the percentage rate, yet the foremost authorities agree as to the rôle played by heredity. In the great majority of cases the hereditary predisposition can be traced to the father of the patient. This is strikingly shown by the number of patients who are brought to hospitals by their mothers, who are generally anemic, and who generally state, if a truthful history is given, that the father died of phthisis or some other form of tuberculosis. The difficulty of arriving at any correct statistics as to the part heredity plays in the production of tuberculous joint disease can readily be understood by the misstatements made by parents and relatives of patients in regard to the family history. It is a noteworthy fact that the cause of joint disease is usually ascribed to traumatism

by parents, relatives, and friends. All statistics should therefore represent at least the minimum percentage of cases having a hereditary tendency.

Acquired Predisposition.—Among certain classes there is an acquired predisposition to the development of tuberculous joint disease. Any condition which lowers the general resistance of the patient predisposes to tuberculous joint disease. It is a well-known fact that in apparently healthy individuals there have been found at autopsy evidences of tuberculosis of the bronchial and mesenteric lymph-nodes. This is known as latent tuberculosis, and it only requires some favorable general or local condition for the focus to develop into active tuberculous processes throughout the body. Among the conditions predisposing to acquired tuberculosis may be mentioned poor hygienic surroundings, bad air, absence of sunlight, improper food, and principally infectious diseases, which rapidly lower the vital resistance. The great prevalence of tuberculosis in thickly populated cities where people are closely housed, use food of a poor quality, and pay little heed to the laws of hygiene is so well known as to require little comment.

Local Predisposition—Traumatism.—Among the local predisposing causes, traumatism plays a great part. Most patients give a history of having injured the involved joint at some previous time, and naturally assert that the condition is due to traumatism. These injuries are generally of a mild nature and cause very little, if any, inconvenience at the time. It has been shown experimentally by Krause and others that tuberculous joint disease generally follows only moderate injury. By inoculating susceptible animals with tuberculous material and then contusing various joints Krause was able to produce typical joint lesions. When the traumatism was severe, as in fractures, he found that secondary involvement of the joint did not occur. The cause of this is explained by the fact that following mild injuries local congestion occurs during the course of repair, which offers suitable soil for the growth of the tubercle bacilli, while following injuries of a severe nature the process of repair is so active that the tubercle bacilli are generally destroyed. The statistics on the local predisposition caused by injury are interesting. In 845 cases C. F. Taylor states that 53 per cent. were due to injury. Gibney gives 42 per cent. in an analysis of 596 cases; Croft, 35 per cent. Whitman states that the combined statistics of Hildebrand, König, Mikulicz, and Bruns show that in 513 of 3398 cases of tuberculous disease of the bones and joints injury seemed to be a direct predisposing cause of the local disease. Albrecht considers that about one-

sixth of all tuberculous joint lesions follow injury. The statistics showing the infrequency of tuberculous lesions following severe joint injuries bear out the statement made above. In 845 cases of spinal paralysis occurring in children who, on account of the disease, are constantly subject to joint injury, Gibney states that in only four instances were there joint diseases. In 100 cases of fracture about the elbow observed by Roser there resulted no tuberculous lesion.

Static Predisposition.—The greater liability to the development of tuberculous lesions in the joints of the lower extremities as compared with those of the upper extremities is explained by the greater liability of the joints of the former to injury and to the fact that they are required to bear the weight of the body and cannot be placed at rest with the same degree of ease without requiring the patient to take to bed. The combined statistics of the Boston Children's Hospital, the Hospital for Ruptured and Crippled, and Vanderbilt Clinic, those of Thorndike, Cheyne, Jaffé, Schmalfuss, Billroth, Mentzel, and Judson, show that, in a great number of cases, the lower extremity was the seat of tuberculous joint disease in 57.6 per cent., while the joints of the upper extremity were affected in only 4 per cent. of the cases.

Exanthemata.—To the acute exanthemata should be ascribed in a large percentage of cases the production of tuberculous joint disease. This is particularly evident in scarlet fever and measles.

Age.—A very great proportion of cases of tuberculous joint disease occurs in childhood. This is due to the following reasons: (1) The greater liability to the development of bone disease during the period in which the osseous structures are rapidly growing and tissue changes are very rapid; (2) during early life children are especially liable to slight joint injuries occasioned by repeated falls; and (3) more people are alive from five to ten years than at later periods of life.

Thorndike has observed a case of tuberculous disease of the hip during the first week of life and several cases of the same disease of the spine and hip during the first six months.

Knight's statistics, quoted by Whitman, on 5461 cases of tuberculous disease treated at the Hospital for Ruptured and Crippled show that about seven-eighths of the patients were less than fourteen years of age.

Less than fourteen years of age,.....	{	Vertebras,.....	87.7 per cent.
		Hip,.....	88.2 "
		Other joints,.....	71.7 "

Between fourteen and twenty-one years of age, .	Vertebras,.....	7.7	per cent.
	Hip,.....	9.2	"
	Other joints,.....	10.7	"
More than twenty-one years of age,.....	Vertebras,.....	4.5	"
	Hip,.....	2.5	"
	Other joints,.....	17.5	"

Gibney reported 860 cases of tuberculous joint disease, of which 84.5 per cent. occurred before fourteen years of age. In 1344 cases of hip-joint disease from the combined statistics of Wright, Bryant, and Sayre there were 1000 occurred before the fifteenth year.

Sex.—While sex plays but little part in the occurrence of tuberculous joint diseases, males are affected more frequently than females, the cause being the greater liability to injury among boys, who, as a rule, lead a more active life.

The combined statistics of König and Gibney show that in 1218 cases of tuberculous knee-joint disease, there were 703, or 57.6 per cent., occurred in males.

Side Affected.—The right side is slightly more frequently affected by tuberculous joint disease. This is accounted for by the fact that the great majority of people use the right side more frequently than the left. The part injury plays as a predisposing factor is well shown by the relative frequency of joint lesions occurring in the right upper extremity as compared with the left lower extremity. Most people are right-handed, and necessarily injure the right upper extremity more often than the left. Yet the difference in training between the two lower extremities is never marked, and on this account very little difference is shown in the side affected in the lower extremities.

Distribution of Tuberculous Joint Disease.—The following combined statistics show the relative frequency with which the various joints are involved:

	GIBNEY (MOSTLY IN CHILD- REN).	HOSPITAL FOR RUP- TURED AND CRIPPLED (WHITMAN).	BOSTON CHILDREN'S HOSPITAL (BRADFORD AND LOVETT).	NEW YORK ORTHO- PEDIC DIS- PENSARY.	CHEYNE (UNDER TEN YEARS).	BOSTON CHILDREN'S HOSPITAL OUT-PATIENT DEPT. (THORNDIKE) (UNDER TWO YEARS).	JUDSON.	TOTAL.	PERCENT- AGE.
Vertebras,.....	209	1432	1964	1024	78	120	577	5404	46.7
Hip,.....	271	1123	1402	1178	44	61	...	4079	34.4
Knee,.....	103	699	104	319	24	29	181	1459	12.2
Ankle,.....	31	196	300	83	4	...	...	614	5.1
Elbow,.....	...	62	15	11	13	...	8	109	0.8
Shoulder,.....	...	42	15	11	2	...	6	76	0.5
Wrist,.....	...	7	20	7	2	...	...	36	0.3
Total,.....	614	3561	3820	2633	167	210	772	11,777	100.0

Polyarticular Joint Disease.—Tuberculous disease may affect several joints at the same time, or one joint may be involved and shortly after a

second joint is affected by the same process. It is rare to have tuberculous disease of two similar joints, as double hip disease, or knee-joint disease. Simultaneous involvement of the hip and spine and of the knee and spine are the most frequent forms of double disease. The knee-joint and wrist-joint and the hip-joint and wrist-joint are occasionally the seat of tuberculous disease at the same time. Double tumor albus is very rarely seen.

Avenues of Infection.—Tuberculous joint disease is usually secondary to other foci in the body, although cases are reported in which no other foci could be found after the most careful search. The latter class of cases may be due to direct infection taking place through the blood following wound infection. There are various avenues by which the tubercle bacilli may gain entrance into the body and set up primary foci of disease. They may be divided broadly into two classes: (1) Infection through the respiratory tract, and (2) infection through the alimentary tract. Primary foci following infection by the respiratory tract are seen in the development of tuberculous bronchial and cervical glands, and following infection by the alimentary tract are seen in the development of tuberculous mesenteric glands. In a great majority of cases, however, there are no clinical signs of tuberculosis with the exception of enlarged cervical glands, as the disease very often remains quiescent and does not set up secondary foci in the viscera or osseous system. When the general surroundings, however, are poor and there occur causes which lower the vital resistance of the individual, secondary foci are very liable to develop. This is especially seen in cases having a hereditary tendency, in cases which have a lowered vitality following infectious fevers, and in cases subject to mild traumatism. Following these predisposing causes visceral and joint tuberculosis is very prone to develop. That tuberculosis is secondary to primary foci in the lymphatic system the statistics of Still, based on autopsies performed on children under twelve years of age at the Hospital for Children, Great Ormond Street, London, show very conclusively. He states that in 769 autopsies there were 269 cases which showed the presence of tuberculous lesions. His table of statistics giving the avenues of infection is as follows:

Respiratory:

Lungs.....	105
Probably lungs.....	33
Ear.....	9
Probably ear.....	6

153 = 57 per cent.

Alimentary:

Intestines,.....	53
Probably intestines,.....	10
	63 = 23.4 per cent.

Other cases:

Bones or joints,.....	5
Fauces,.....	2
Uncertain,.....	46
	53 = 19.6 per cent.

The statistics of Northrup and Bovaird, based on 200 cases treated at the New York Foundling Hospital, are as follows:

Infection by respiratory tract,.....	148
Infection by mesenteric lymph-nodes,.....	4
Indeterminate,.....	48
	200

It is generally possible, in cases that come to the autopsy table in which there is tuberculous joint disease, to find the primary foci in some set of lymph-nodes. This is usually determined by the advanced state of the tuberculous process in the nodes. Haushalter found the tracheo-bronchial glands to be the primary foci in 74 instances of 78 cases of autopsy performed in children who died from acute miliary tuberculosis. That a primary focus cannot always be found is shown by the statement of König that he was unable to locate a primary focus in 14 instances of 67 autopsies performed on patients who had tuberculous lesions of the bones and joints.

Accidental Inoculation.—That inoculation occurs in man by means of the implanation of the bovine tubercle bacillus has been proved by numerous experiments. The cases of Walley, of Edinburgh, and Moses, of Weimer, which ended fatally followed accidental inoculation with the bovine bacillus. Bovine tuberculosis is transmissible to man by direct inoculation and through the medium of food, especially milk. A case is cited by Pfeiffer, of a veterinary surgeon with a negative previous tuberculous family history, who received a wound of the thumb while dissecting a tuberculous cow, developed a tuberculous joint lesion of the thumb, and died in a year and a half from pulmonary tuberculosis. Professor Lassar has observed four cases of “verrucose tuberculosis” of the skin in butchers, which he was inclined to believe were due to bovine tuberculosis. E. W. Watson considers that infection from transmission from cattle occurs more frequently than by the inhalation

of dust containing the tubercle bacilli. Another means of accidental inoculation is cited by Lehmann. He states that he has seen ten cases of tuberculous infection occur in children who had been circumcised by a rabbi who had active phthisis. Of the ten cases seen, seven died. Cases of the same nature are reported by Elsenberg, Mecklen, and Holst.

Pathology.

Presence of a Primary Focus.—In the majority of cases of tuberculous joint disease that come to autopsy there can be found a primary foci of infection elsewhere in the body. This, as stated above, may be in the respiratory or alimentary tract or in the lymph-nodes connected with these two systems. It occasionally occurs, however, that the most careful autopsy examination fails to reveal another focus in the body that can undoubtedly be considered to be the primary seat of tuberculosis. There may be tuberculous joint or bone disease with very extensive lesions, and yet there may be no involvement of the viscera or lymph-nodes. Nichols cites a case which at autopsy showed advanced tuberculosis of the vertebrae, combined with a large psoas abscess opening into the cecum and with marked amyloid disease of the liver, spleen, and kidneys, yet there could be found no evidence of tuberculous involvement of the viscera or lymph-nodes. In this class of cases the osseous lesion must be considered primary, and the avenue of entrance may occur through an abrasion of the skin or mucous membrane and infection occur directly through the blood in the bone without causing a tuberculous lesion at the point of entry. We must therefore consider that, while tuberculous disease of the bones and joints is usually secondary to a focus elsewhere in the body, it occasionally happens that the osseous lesion is beyond doubt primary.

Formation of the Osseous Focus.—The pathologic changes that take place in the bones and joints are essentially productive, exudative, and necrotic in character. The tubercle bacillus, after being carried from primary foci or being introduced directly from the outside, is deposited in the bone-marrow of the epiphysis. This deposit usually takes place in the epiphyseal line to the diaphyseal side of the cartilage; next in order, at the epiphyseal side of the cartilage; occasionally near the articular cartilage; and very rarely in the periosteum. As the bacilli lodge in moderate numbers their toxins produce as one of the early effects a marked proliferation of the connective tissue and endothelial cells. The latter are sometimes known as

“epithelioid” cells. There occur along with this proliferation of connective tissue and endothelial cells a marked emigration of leukocytes and extravasation of serum and multinuclear or “giant” cells. The endothelial cells consist of large oval nuclei and indistinct granular protoplasm. The multinuclear cells contain from twenty to thirty vesicular nuclei which may be grouped in two ways, having either a “bipolar” or a “mural” arrangement. The center of these multinuclear cells is usually finely granular or necrotic and does not stain distinctly. Both the endothelial and multinuclear cells have a phagocytic action. Generally there form in and about the tuberculous area numerous small spheroidal mononuclear or “lymphoid” cells. These mononuclear cells have a small, deeply staining nucleus surrounded by a small amount of indistinct protoplasm. The stroma connecting the cells is made up of processes from the endothelial and multinuclear cells. Blood-vessels are not apt to develop under the influence of the tubercle bacilli, the old blood-vessels being obliterated as the new tissue forms. The formation of the tubercle therefore consists of endothelial and multinuclear cells surrounded by the small spheroidal mononuclear cells. As the tubercle enlarges there occurs a damage to cells and tissue which leads to coagulation necrosis, first manifested in the center and progressing outward. The nuclei of the cells became fragmented or disappear, fail to stain, the protoplasm becomes homogeneous, the cells and stroma forming at last an irregular mass of tissue detritus in which are seen small areas of fat. This condition is known as caseation or coagulation necrosis. As this state advances the gray translucent appearance which the early tubercle presents becomes opaque and yellowish-



Tuberculous focus in end of femur.

FIG. 58.—TUBERCULOUS FOCUS IN FEMUR (Nichols).

white in the center. Within the tubercles there are found in small numbers the tubercle bacilli, which may be present in the cells or in the stroma.

By multiplication and extension of the tubercle bacilli new tubercles are formed about the original deposit. These coalesce and enlarge until large tuberculous areas are formed.

While the process of tubercle formation occurs, the tissues about become congested, owing to an effort of nature to wall off the tuberculous area which is acting as a foreign body. A poorly nourished edematous granulation tissue is formed, which contains numerous small blood-vessels and "plasma" or "lymphoid" cells. These latter cells are generally rounded or polyhedral, about the size of a leukocyte, having a round or oval nucleus which is eccentrically placed, showing irregular groupings of chromatin, the body of the cell being characterized by the staining of its protoplasm with basic anilin dyes. Usually this feebly nourished granulation tissue becomes readily infected with the tubercle bacilli and rapidly undergoes the changes noted above in the formation of tubercles. As the process extends the peripherally placed granulation tissue invades the cancellous structure of



FIG. 59.—SOLITARY EARLY TUBERCLE IN BONE-MARROW (Nichols).

the bone and produces either a partial absorption of the trabeculae, or, if the process is very rapid, the structure of the bone is retained but sequestra are formed.

Bone Abscess.—As new tubercles are rapidly formed, liquefaction necrosis takes place in the center of the diseased area, the trabeculae become

softened, necrotic, and are gradually set free in a central cavity which is made up of surrounding granulation tissue and is known as a "bone abscess." This abscess has a well-defined membrane and consists of purplish-red granulation tissue in which are numerous tubercles. Extending around this membrane there is considerable infiltration of marrow spaces with edematous

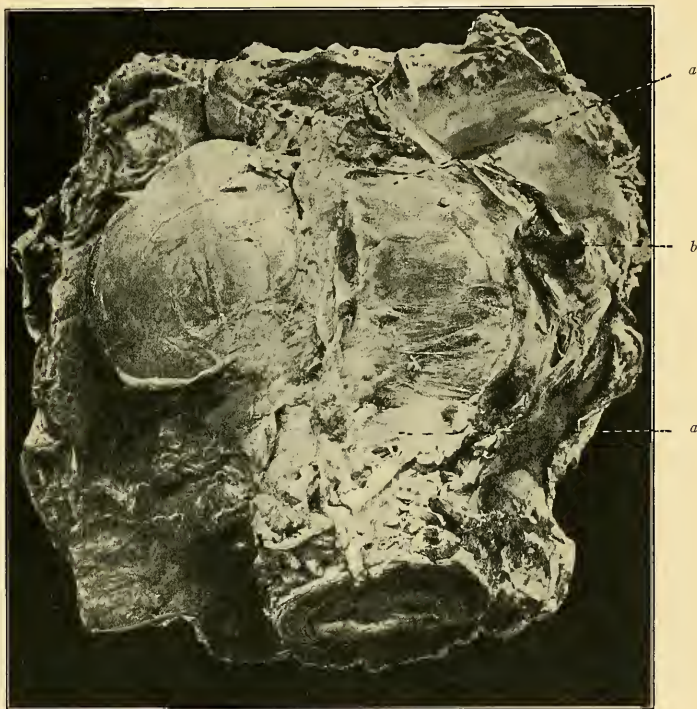


FIG. 60.—TUBERCULOUS DORSAL ABSCESS OF SPINE (Schulthess).
a, a, Aorta; *b*, adherent lung.

connective tissue. The inner layer of this cavity consists of tubercles and granulation tissue in all stages of necrosis, while the outer layer contains tissue consisting of poorly nourished granulations in which, as a result of the invasion of the tubercle bacilli, tubercles are beginning to develop. The contents of the "bone abscess" consist of a whitish-yellow fluid containing broken-down granulation tissue, fragments of partially dissolved bone,

sequestra of various sizes, serum, and leukocytes. Rarely the local resistance is effective, and then the granulations contain more blood-vessels, are firmer and better nourished, the trabeculæ are harder and more resistant, until finally around the focus there occurs a peripheral wall of granulation tissue which shuts in the diseased area; and if the latter is small, complete absorption and replacement by scar tissue take place. Generally, however, this



FIG. 61.—LUMBAR ABSCESS OF SPINE (Wistar Institute of Anatomy).

condition does not occur, but instead the granulations are feeble, contain a small proportion of blood-vessels, the local resistance is very poor, no surrounding wall of firm granulation tissue occurs, and gradually the area of disease increases by continual extension of deposits of tubercle bacilli. Coincident with this extension there occurs central necrosis, until a well-marked "bone abscess," as described above, occurs.

Sequestrum Formation.—Occasionally, however, instead of producing a bone “abscess” the tuberculous lesion consists of the formation of a “sequestrum,” or an irregular area of necrotic bone which lies free in a cavity of the bone. This “sequestrum” is produced by a process similar to the formation of an abscess, except that the trabeculæ retain their shape, and, while they become necrotic, do not entirely dissolve. The surrounding marrow spaces are filled with caseous material. The diseased bone over a considerable area finally separates from the surrounding structures and remains free in a cavity, the walls of which contain a well-defined membrane covered with numerous tubercles. When reparative changes take place in the tuberculous area, the walls of the cavity become dense, sclerotic, and finally of bony consistence, and the sequestra may remain *in situ* for years.

Bone Infarct.—When tuberculous epiphysitis is secondary to a focus elsewhere, it is occasionally seen as a wedge-shaped process having its base directed toward the articular cartilage and its apex directed toward the epiphyseal line. Such an arrangement is known as a “bone infarct,” and is similar to

an infarct occurring in other organs, being due to the lodgment of a tubercular embolus in the bone artery supplying the involved portion of the epiphysis.

Terminations of an Osseous Focus.—Tuberculous epiphysitis may terminate in any of the following ways: (1) The local resistance is so effective that the focus is finally surrounded by dense fibrous tissue, and if small,



FIG. 62.—SECTION OF CERVICAL VERTEBRAS, SHOWING SEQUESTRUM (Schulthess).

a, Odontoid process; b, cross-section through the posterior border of foramen magnum; c, cross-section of the atlas, posterior part; d, same, anterior portion.

may be absorbed, or if large, encapsulated; (2) extension may take place and perforation occur through the cortex of the bone outside the joint, or "extra-articular" perforation; and (3) extension may take place and perforation occur inside the joint, or "intra-articular" perforation.

That small tuberculous foci occasionally undergo absorption is probably true, although Nichols states that actual demonstration of this fact is very difficult. When it does occur, the focus is surrounded by firm, well-nourished, granulation tissue; around this the bony structure proliferates and incloses the diseased area, and if this is small, it is completely absorbed and replaced by scar tissue; if the area is comparatively large, it becomes encapsulated.

Extra-articular Perforation.—Frequently, however, the diseased process enlarges, extends to and perforates the cortex of the bone extra-articularly, and subsequently involves the surrounding soft parts. Extra-articular perforation is more common in those joints in which the capsule is relatively small and the joints are superficially located. This is especially seen in such joints as the knee, elbow, and ankle. In those joints that are deep and in which the capsule is very extensive, as the hip, shoulder, and where the bones are in close contact with each other and surrounded generally by ligaments so as to make extra-articular perforation impossible, as the spine, intra-articular involvement always occurs.



FIG. 63.—TUBERCULOUS KNEE-JOINT, SHOWING PRIMARY AREA OF CASEATION IN THE EPIPHYSEAL LINE (Nichols).

a, Epiphysis; *b*, primary tuberculous focus; *c*, shaft.

Cold Abscess Formation.—Following perforation of the cortex and periosteum and involvement of the surrounding soft parts, a tuberculous or "cold abscess" occurs. Here is found a similar but more rapid formation of secondary tubercles which extend peripherally with central necrosis as seen in involvement of the cancellated structure of bone. These abscesses spread in the direction of least resistance, usually in the intermuscular septa. The walls of this abscess are of a grayish-yellow color and the surrounding soft parts consist of softened tuberculous tissue around which is poorly nourished, edematous granulation tissue. As the tuberculous process extends, abscesses of very large size may be formed which travel in the direction of least resistance in intermuscular septa until, at times becoming superficial at some distance from the original bony focus, they perforate the skin at several places and partially discharge their contents.

Contents of a Cold Abscess.—The contents of a tuberculous abscess cavity are generally composed of a thin whitish occasionally reddish fluid, formed from the remains of caseous tubercles, leukocytes, fibrin, serum, and the necrotic remains of partially destroyed soft and bony tissue. The reddish or brown color which is occasionally seen is due to fresh or decomposed blood. Careful search with the microscope will generally show the presence of the tubercle bacilli free in the pus, but they are more numerous in the walls of the abscess. Krause considers that the tubercle bacilli are present in the contents of "cold abscesses" in about one-third of all cases, and Nichols states that he has never failed to produce general tuberculosis in susceptible animals—*e. g.*, guinea-pigs—after inoculation with pus from these abscesses.

Fistulas.—The points of exit of these abscesses are known as "tuberculous fistulas," and are generally several in number. The walls of the sinuses are composed of dense tuberculous tissue surrounded by an area of granulation tissue of bluish-white color, which contains very few blood-vessels and is readily infected. The fistulas are irregularly circular, protuberant, and generally of small caliber when compared with that of the sinuses with which they are continuous.

Intra-articular Perforation.—While the most favorable termination of tuberculous foci is absorption or encapsulation, which very rarely occurs, and next extra-articular perforation, which occasionally occurs, the most frequent result is intra-articular perforation and infection of the entire synovial membrane. As the tuberculous focus within the epiphysis increases in size, it extends peripherally until it reaches a joint just beneath the articular cartilage. Before perforation into the joint takes place there occur primary changes within the joint, which is apparently an effort of nature to limit the area of joint involvement. These changes consist in congestion and hypertrophy of the synovial membrane, moderate effusion into the joint cavity, and the deposit of fibrin upon the cartilage and synovialis. These changes usually precede perforation, and if this latter does not occur, there may be more or less destruction of the articular cartilage due to the intra-articular changes. The cartilage in proximity to the tuberculous foci rapidly disintegrates, becomes fibrous and yellow, irregular spaces occur through which perforation finally takes place in several places, and the cartilage is either destroyed gradually or is entirely separated from the underlying bone by the tuberculous process. After perforation occurs the hypertrophied

synovial membrane is rapidly covered by the development of discrete tubercles which multiply peripherally, coalesce, and finally produce large tuberculous ulcers. The cartilage may be destroyed either by extension of the hypertrophied synovial membrane in a pannus-like growth, causing extensive ulcers of the cartilage and successive disintegration, or the tuberculous process extends between the cartilage and bone, separating large areas of cartilage from the underlying bone, leaving beneath bone which is irregularly

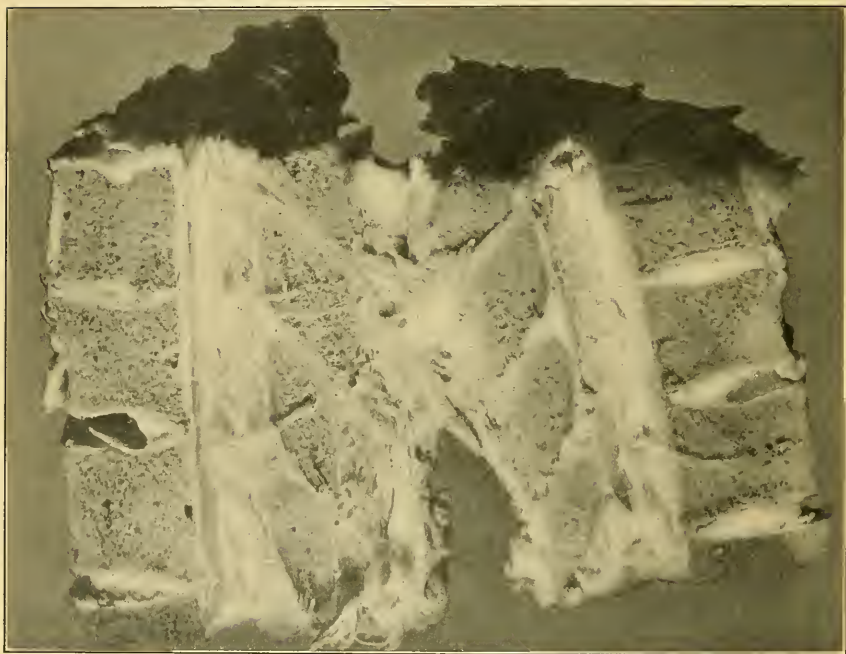


FIG. 64.—TUBERCULOUS DISEASE OF BODY OF VERTEBRAS AND INTRAVERTEBRAL DISEASE (Wistar Institute of Anatomy).

nodular and covered with tubercles in all stages of coagulation necrosis. In time there may remain but little, if any, vestige of cartilage, the articulating ends of the bones become markedly eroded, irregular, and shortened, which is accelerated by friction due to muscular spasm.

Joint Abscess.—The perforation of the joint is followed by what may be termed a “joint abscess.” The clear, yellowish, fibrinous character of

the fluid of the joint which is present before perforation takes place is soon changed to a turbid character due to the presence of polymorphonuclear leucocytes, and later the entire joint is filled with an opaque fluid in which are masses of fibrin, necrotic portions of soft, articular, and bony structures, and in which normal joint structures are indistinguishable. When the destructive changes have progressed to a certain stage, there occurs perforation of the capsule of the joint and the formation of a secondary abscess. This generally occurs when the surrounding extra-articular structures are the seat of edematous infiltration and various secondary changes. As a rule, this is mostly marked by the formation of connective tissue about the muscles and tendons, so that the parts finally consist of an indefinite mass, the characteristics of which are found in the peri-articular swelling which occurs about all chronic joints. As secondary abscesses develop they generally follow the lines of least resistance, produce secondary changes in the surrounding soft parts, rapidly form large abscess cavities, and finally reach the surface at some distant point, where they perforate the skin in several places, with the formation of tuberculous fistulas.

There is a tuberculous joint lesion, most frequently seen in the shoulder, in which the amount of fluid is small and abscess formation very slight. This condition is known as "caries sicca." There is a formation of thin, slightly vascular, granulation tissue, which gradually destroys the head of the bone, and in advanced cases the disease may involve the shaft of the bone.

Spina Ventosa.—Tuberculous disease of the phalanges of the hand and foot is occasionally seen as an example of tuberculous infection of the diaphysis. It is sometimes termed "spina ventosa." The process consists of a tuberculous process attacking the marrow, while at the same time there occur successive layers of new cortical bone formed by the periosteum. As the condition progresses the central portion of the shaft of the bone is finally converted into caseous tuberculous matter, containing numerous portions of bone trabeculæ. Occasionally large sequestra are formed. As each new

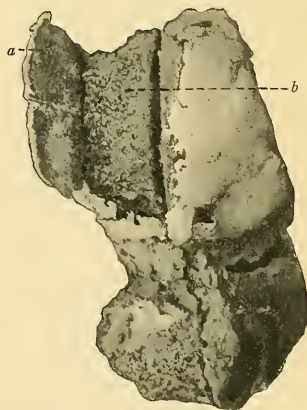


FIG. 65.—SEPARATION OF ARTICULAR CARTILAGE (Nichols).

a, Elevated cartilage; b, head of femur. Surface tubercles.

layer of periosteal bone is formed, the bone increases in circumference and finally becomes spindle-shaped. At times the tuberculous process is so rapid that there remains only the periosteum as a very thin shell. The tuberculous area generally discharges externally in several places. The disease is usually seen in children, is sometimes found simultaneously in several phalanges or metacarpals at the same time, but rarely are two adjacent bones involved. The cartilaginous ends of the bones are not affected and the condition is met with at times in children who have other tuberculous bone or joint lesions.

Atypical Tuberculous Joint Lesions.

Secondary Tuberculous Synovitis.—Whether tuberculous infection of the synovial membrane occurs as a primary condition is not definitely settled. Many writers, especially the Germans, claim that primary tuberculous synovitis is seen in about 20 to 35 per cent. of cases. Volkmann, Krause, König, and Watson Cheyne consider that primary infection of the synovial membrane occurs, that it is more often seen in children, and most commonly at the knee-joint. Nichols, on the other hand, doubts very much the existence of primary tuberculous synovitis, and bases his statements on the most careful examination of 120 tuberculous joints from children and adults.

The work of Nichols has been so thorough and complete, and is based entirely upon the examination of pathologic specimens, that one is led to believe that the situation of the disease without any doubt primarily takes place in the epiphyseal ends of the bone, and that the synovial membrane is always secondarily involved. His researches clear up to a marked extent cases that for a long time show nothing but a simple chronic synovitis plus moderate peri-articular induration. This condition, while it may exist for a long period, is always preliminary to the perforation of the joint, which takes place sooner or later. This class of cases, while showing clinically nothing more than a chronic synovitis, with the exception of a little muscular spasm, slight limitation of motion, and moderate peri-articular induration, may continue in this stage for a considerable period, when, owing to loss of local resistance, the tuberculous process becomes active and all the signs of a tuberculous joint lesion develop. The chronicity of the condition is explained on the supposition that repeated successful efforts have been made by nature to inclose the diseased focus, and the joint changes are due to a sympathetic inflammation.



FIG. 66.—CARIES SICCA—HEAD OF HUMERUS (Wistar Institute of Anatomy).

Caries Sicca.—This form of tuberculous joint disease is characterized by the formation of thin, poorly nourished granulation tissue which rapidly involves the epiphysis and destroys the bone without the formation of fluid or any marked caseation. This condition is usually seen in tuberculous disease of the shoulder-joint. The process begins by the formation of deep furrows and sinuses at the anatomic neck, the head of the bone is rapidly destroyed, and in many instances the shaft of the bone is involved. There is little tendency to the formation of sequestra. Coincident with the destruction of the head of the bone shrinkage of the capsule takes place, so that the upper end of the shaft is drawn upward toward the glenoid cavity, and this, combined with the effect of muscular spasm, produces marked deformity.

Rice Bodies.—While “rice bodies” are usually seen in tuberculous lesions of the tendon-sheaths and bursas, they are occasionally met in similar affections of joints. These bodies are of irregular size, generally about the size of pieces of rice to melon-seeds, grayish-white, smooth, numerous, and may assume various shapes dependent upon their number and their situation. Occurring in joints, they are formed from villous projections from the hypertrophied synovial membrane. They may be free or pedunculated, and are generally surrounded by a slightly turbid fluid. When involving bursas and tendon-sheaths, they present marked enlargements of the bursas and tendon-sheaths, and in the former condition are sometimes confounded with sarcoma, especially when the subdeltoid bursa is affected. The condition may advance to the formation of cold abscesses.

Mixed Infection of Tuberculous Joint Lesions.—While the great majority of tuberculous joints and abscesses, when not communicating with the exterior, remain uninfected with other pyogenic organisms, yet occasionally closed lesions, and generally all open areas of tuberculous suppuration, sooner or later become infected with other pyogenic organisms, and the condition is termed “mixed infection.” The most frequent organisms causing secondary or “mixed infection” are the streptococcus, staphylococcus, the pyogenes aureus and citreus, and colon bacillus. When this infection takes place in closed lesions, the condition known as “cold abscess” is changed. Local signs of an acute inflammatory process rapidly become manifest. When the cold abscess has been incised or has ruptured and infection takes place, the discharge rapidly increases in quantity and quality, local signs of acute inflammation develop, and the lining wall of the abscess is rapidly changed. If drainage is free, some systemic signs of the infection will appear for a few

days, but will rapidly subside, and in most cases the local tuberculous process may be benefited by the increased blood brought to the part and by the antagonistic action of the toxins produced by the pyogenic organisms causing the tubercle bacilli to lose their virulence. If, however, drainage is not free and the discharge has but a small chance to escape, the joint is rapidly destroyed, abscesses form between the various layers of muscles, and constitutional effects of the mixed infection soon become manifest. As a result general resistance is lowered, tuberculous dissemination is favored, and amyloid degeneration of the internal viscera rapidly occurs. If the condition progresses, the only hope of saving the patient's life will depend upon thorough removal of the part by amputation.



FIG. 67.—VERTEBRAL CARIES, SHOWING ANKYLOSIS FROM EXOSTOSES (Wistar Institute of Anatomy).

Repair of Tuberculous Lesions.—During the entire active stage of tuberculous lesions nature makes efforts at repair. For a time the local condition may be so poor that efforts at resistance are futile and the surrounding wall of granulation tissue soon becomes invaded by the tubercle bacilli. The process of repair, however, may occur at any stage of the disease. Small areas of disease are absorbed, and replaced by scar tissue. The main factor at work in the process of repair is the formation of surrounding granulation and fibrous tissue. Cavities are filled and replaced by fibrous tissue, sequestra and caseous material are encapsulated by granulations which later are converted

into fibrous calcified tissue. Joint cavities are generally obliterated and the articular surfaces united by fibrous, cartilaginous, or bony ankylosis, or by a combination of the three. Ankylosis may take place in any position dependent upon the presence or absence of deformity maintained during the active stages of the disease. Complete healing does not always take place until some little time has passed. There generally persist small areas that are lightly encapsulated and sinuses which lead down to a sequestrum. These semi-active foci are liable at times to start afresh the previous tuberculous lesions. This is especially so when efforts are made too early to correct deformities in the endeavor to secure a fairly movable joint.

In recovery from tuberculous joint lesions in children it is necessary to bear in mind the changes which are liable to occur as a result of a partial or complete destruction of the epiphysis. As a rule, the entire epiphysis is not destroyed by the tuberculous process, and there later result changes in the position and perhaps accentuation of the deformity as a result of the increased growth of the part not affected by the disease. This is seen in the production of valgus and varus deformities and other varieties of lateral and anteroposterior deformities. As a result of irritation of the epiphysis caused by the tubercle bacilli there is generally an increased growth with appreciable lengthening of the limb. As a result of the enforced rest necessitated by the diseased process there is a retardation in growth of the bony structures of the entire extremity affected.

Diagnosis.

An early diagnosis of tuberculous joint disease is extremely valuable, so that the recognition of the condition is positive, and early treatment, upon which to a great measure depend good results, instituted. In the later stages the clinical picture cannot be mistaken, but the early diagnosis is, in many cases, extremely difficult. The clinical picture presented in the primary stages may give some suggestion as to the condition. Among these may be mentioned tendency to joint weakness, early exhaustion, slight muscular spasm, muscular atrophy above and below the joint, localized tenderness over the epiphysis, slight effusion, and peri-articular edema. As an aid to clinical signs the tuberculin reaction has been extensively used. It is of value as a negative test showing the absence of tuberculous lesions in the body, but its usefulness as a positive test is practically *nil*, when we consider the fact that



FIG. 68.—TUBERCULOUS HIP-JOINT DISEASE (Wistar Institute of Anatomy).

joint lesions are usually secondary to a tuberculous condition of the lymphatic glands. The *x*-ray photograph is of little value in the early diagnosis of tuberculous lesions, as it fails to reveal foci until they are of large size. It may be of use in showing changes in the head and neck of the femur in early disease, on account of the static changes which occur. Positive early diagnosis is difficult, but if the disease has invaded the synovial membrane, arthrotomy, and inspection of the membrane and the excision of a small portion, followed by histologic examination and inoculation into susceptible animals, offer the only means by which the condition can be absolutely determined. The author does not recommend this latter method of diagnosis.

Prognosis.

The prognosis in tuberculous joint disease is dependent upon a number of conditions. The patient's general surroundings greatly influence the prognosis. Anything which lessens the general as well as the local resistance tends to favor the growth and dissemination of tuberculosis. These include lack of proper food, air, and exercise. Age affects the prognosis of tuberculous joint diseases. This is in part due to the increased frequency of the presence of phthisis among adults even before the development of the joint lesions, and in part due to the natural retrograde changes which take place with increasing years. This influence of age upon the death-rate is shown by the following statistics of König on tuberculous disease of the knee-joint:

Less than fifteen years of age, ...	20 per cent.
From sixteen to thirty years, ...	24 "
From thirty to forty years, ...	44 "
More than forty years, ...	60 "

The prognosis is dependent upon the situation, its accessibility, its proximity to surrounding structures, and the degree with which it can be treated without subjecting the patient to undue pain or confinement. Dependent upon situation and proximity to important structures, it may be stated that the danger to life is much greater in disease of the vertebrae than when the lesion involves joints of the extremities. Pressure upon the spinal cord is liable to occur, and the danger from this source is greater in tuberculous disease of the cervical than of the dorsal or lumbar vertebrae. Disease of the cervical vertebrae is more difficult to treat than similar lesions of other joints. Abscess formation is more dangerous in vertebral disease: on account of their size and proximity to important structures there is danger of compres-

sion and rupture into important viscera, and of thereby setting up secondary lesions. The prognosis is much better in tuberculous lesions of joints which are readily accessible to prompt treatment. This is seen in the more grave prognosis in hip-joint disease than in other joints. In disease of the knee-joint the parts are so superficial that the condition is readily recognized, and if operative measures are instituted, the parts are very accessible. Joints that can efficiently be treated without confining the patient or without causing much pain yield more readily to treatment, and, all things considered, the danger to life is not so great. Abscess formation materially increases the gravity of the prognosis. König's and Bruns's statistics showing that the mortality is increased very markedly when abscesses occur are as follows:

	JOINT AFFECTED.	WITHOUT ABSCESS.	WITH ABSCESS.
König, ...	Knee-joint.	25 per cent.	46 per cent.
Bruns, ...	Hip-joint.	23 "	52 "

When abscess formation takes place, one of the causes that materially increase the mortality rate is "mixed infection" with pyogenic organisms. While this may be slight in joints which are superficially located, are not in proximity to important structures, and where efficient drainage is present, in cases in which these conditions are not present the effects of systemic infection are seen very early, the general condition rapidly fails, amyloid degeneration of the internal viscera takes place, and the patient succumbs to the combined effects of the disease.

The statistics on the effect operation has upon the spread of tuberculous disease are few and conflicting. As a general rule, however, it may be stated that the statistics show that the death-rate has not been increased by operative intervention.

The statistics on the cause of death are numerous. Billroth and Menzel collected 2106 cases of tuberculous disease of the bones and joints from the autopsy records at Vienna, and stated that 52 per cent. showed tuberculosis of the internal organs. Warthman states that in 837 cases of resection of the hip 10 per cent. of the patients died of general tuberculosis; which he does not consider to have been brought on by the operations. In 386 cases of tuberculous joint disease kept under observation for three years Watson Cheyne states that 10.8 per cent. had contracted or died of phthisis or tuberculous meningitis. Jaffé states that 53 per cent. of deaths are due to general tuberculous infection; Billroth states that 54 per cent. die of acute miliary tuberculosis. Whitman states that among the cases of tuberculosis

of the bones and joints treated at the New York Orthopedic Dispensary and Hospital during a period of twenty years at least 25 per cent. died of tuberculous meningitis. The mortality statistics of cases in which the tuberculous bone foci were removed are interesting in showing that the death-rate is practically unaffected and that the dissemination of the disease takes place generally from the primary focus. König reports that of 117 resections performed for tuberculous joint disease there were 25 deaths, 18 being due to general tuberculosis, and that 9 more cases had tuberculosis in an advanced stage. Caumont's statistics show that in 26 cases of tuberculous hip disease, in which no operations were performed about one-fifth died of generalized tuberculosis, while in 12 other cases in which resection was performed one-third died from the same cause. Gibney considers deaths from generalized tuberculosis, in cases having tuberculous joint lesions, to be no greater in those cases in which surgical interference is instituted. He bases his statements on an observation of the results obtained during two equal periods of thirteen years at the Hospital for Ruptured and Crippled; during the first period the cases were treated by conservative means. From the above statistics it may be inferred that operative intervention has practically no influence upon the dissemination of tuberculosis from the primary foci, but it cannot be doubted that some benefit must follow in the improved general condition by the removal of a suppurating focus of disease.

Treatment.

It is needless to state that the general hygienic surroundings should receive the most careful attention. The food should be easily digestible and very nourishing. Patients should spend as much time as possible in the open air. This has been made possible in late years by the various methods of ambulatory treatment which have almost entirely supplanted the older methods which necessitated spending long periods in bed. This has changed to such a degree that but few cases now require recumbent treatment. General tonics, such as hypophosphites, cod-liver oil, and preparations containing iron, arsenic, and strychnin, may be used to advantage; but their continued use over long periods is not advised on account of the destructive action many such preparations have on the teeth, the decay of which does not tend to increase the patient's general health.

Conservative Treatment.—The results obtained by conservative treatment in tuberculous joint disease have during the past few years been so

good that many orthopedic surgeons consider that operative intervention is generally, if not always, inadvisable. The good results obtained by conservative treatment are due to the improved methods of fixation and extension, which permit of ambulatory treatment, and the great strides that have been made in the improvement of orthopedic apparatus. Contrasting non-operative with operative treatment, it will be found that the prognosis under the two methods of treatment varies but little. The essential features of conservative treatment are absolute fixation and extension permitting of ambulatory treatment and the spending of as much time as possible in the open air. Fixation and traction may be obtained in most tuberculous joint lesions by means of suitable orthopedic braces and splints of various materials. As soon as the diagnosis is made, treatment should be immediately instituted. If seen early, suitable ambulatory apparatus or splints should be applied. If the disease is well advanced and muscular spasm and deformity are present, it may be necessary to overcome both by the recumbent position in bed and traction. The continuous use of plaster-of-Paris dressings applied every week without any attempt being made to correct the position will soon overcome the deformity and lessen the muscular spasm. After the latter conditions have been overcome suitable ambulatory apparatus should be used.

Local Measures. Iodoform Emulsion.—Local measures may be used to good effect as supplementary to conservative measures. Among these may be mentioned iodoform. The results obtained by the injection of iodoform into joints are often striking, and although its favorable influence is not constant, yet many cases of joint disease are greatly improved and the joint effusion may disappear rapidly and permanently. The action of iodoform is supposed to promote the growth of well-nourished granulation tissue which to a certain extent destroys the tubercle bacilli and later forms fibrous tissue. The germicidal action of iodoform is doubted very much. At one time iodoform was injected into the bone near the osseous focus, but lately this treatment is no longer used, and the only cases in which the injections are used are those of synovitis, bursitis, tenosynovitis, and abscesses. The iodoform is used in the form of a 10 per cent. emulsion made of sterile glycerin or oil. General anesthesia is not necessary. The technic of injecting consists in aspirating the affected joint at the most convenient position under strictest aseptic precautions. The fluid within the joint is removed and 5 to 10 c.c. of the iodoform emulsion is injected. The wound should be sealed with a sterile dressing. The injection is repeated every ten to

fourteen days. At the end of twenty-four hours there are generally signs of marked irritation about the joint, moderate fever, an increase in the effusion, and pain. All these symptoms, however, rapidly subside. The results of the first injections are carefully noted and the tolerance of the individual established. Good effects are shown by the moderation of the process and signs of cicatrization and healing within the joint. In cases in which abscess formation has occurred, its favorable action is shown by a greenish character of the pus and by the tendency of the fluid to become serous. While injections of iodoform have in some instances been followed by fatal cases of poisoning, yet under careful treatment and noting the local and general action of the iodoform one can usually see the signs of danger and the personal tolerance.

Carbolic Acid.—The injection of dilute solutions of carbolic acid instead of iodoform emulsion in the treatment of tuberculous joint disease has been advocated by some authors. König recommends that the joint be aspirated and all effusion withdrawn; then irrigated with a 2 per cent. carbolic acid solution, after which a 5 per cent. solution of the same is allowed to remain in the joint. The after-results and further technic are similar to injections of iodoform. König claims to have good results from this form of treatment. In the use of weak solutions of carbolic acid there is always the danger of poisoning from absorption, and on this account it is very little used. The use of pure carbolic acid in the treatment of tuberculous abscess cavities, sinuses, and skin tuberculosis has been followed by good results. It differs from dilute solutions in that it is not absorbed, but has an entirely local escharotic action, while the latter is absorbed. In using the pure carbolic acid the walls of the cavity, if accessible, should be swabbed and the acid neutralized by 95 per cent. alcohol, which should be followed by irrigation with normal salt solution. Other agents used which depend entirely on their local escharotic action are chromic acid, chlorid of iron, nitric acid, tincture of iodine, and the Paquelin cautery. By their local action these agents destroy the tubercle bacilli in the lining walls of the abscess, hasten the separation of the infected granulations, and promote the formation of more healthy granulation tissue.

Externally in the early stages of tuberculous joint disease counterirritants, like tincture of iodine, cantharides, and the Paquelin cautery, may help in promoting the absorption of the effusion within the joint.

If tuberculous skin lesions develop from extension from a tuberculous

fistula, satisfactory results may be obtained by the local use of iodoform, ichthyol, tincture of iodine, and balsam of Peru. If more powerful agents are required, the escharotics mentioned above may be used.

Passive Congestion.—The treatment of tuberculous joint disease as suggested by Rokitanski and later used extensively by Bier has been recommended by many orthopedists. While of limited use in this country, it is undoubtedly of value in certain selected cases. The method consists in causing local passive congestion about the diseased joint. This is produced by constricting the limb above the joint by means of a rubber bandage, placed sufficiently tight to arrest the venous but not the arterial blood-current. A flannel bandage is then applied from the distal end of the extremity to below the affected joint. The joint region becomes cyanotic, edematous, and local temperature is increased. No pain should be produced. The daily treatment should last from twelve to fourteen hours. Bier claims that the effects produced by passive congestion are: (1) It hastens the formation of fibrous tissue and causes hypertrophy of the bones; (2) it assists in absorption of the effusion and such new-formed tissue as is liable to prevent joint motion; (3) pain is lessened and joint motion is much freer; and (4) it has a bactericidal effect in infectious joint diseases, particularly tuberculosis. At present there is little to show that passive congestion has any real curative power in early tuberculous joint disease. That it relieves pain and facilitates freer joint motion is well understood. Many cases are not at all benefited. The formation of abscesses takes place more rapidly under this form of treatment. Bier considers this as a favorable sign. They may be aspirated and injected with iodoform emulsion. Large abscesses should contraindicate its use. At present statistics on the subject are meager. Some authorities report very favorably, others have had poor results. No doubt as more cases are observed under this form of treatment a selection of suitable cases will be possible, so that in time the indications for its use will be more exact. The method when used should be closely observed in all cases.

Radiotherapy.—The good results obtained in the treatment of tuberculous skin lesions by the α -ray have led to its use in tuberculous joint affections. While it is impossible to say whether its use is followed by good results in the intra-articular affections, there can be no doubt that in cases in which there are discharging sinuses with extension of the process to the surrounding skin much benefit attends its application. No statistics on this

form of treatment have so far appeared, yet in suitable cases it may be used.

Final Results Obtained under Conservative Treatment.—The average period of conservative treatment is from two to five years. Statistics show that under this form of treatment muscular atrophy is less, there is generally less shortening, there is a smaller percentage of abscess formation, there may be more cases of contraction, the period of treatment may be prolonged, but there is never any danger of a flail joint resulting. If cases when first observed are far advanced, operative treatment may be necessary not only to combat the active tuberculous lesion, but to overcome any deformity that may be present. If contractures and ankylosis occur, they may require tenotomy or osteotomy, which, however, should not be performed until all signs of active disease have long since disappeared.

Operative Treatment.—With the advent of improved orthopedic apparatus and the advancement made in conservative treatment, fewer cases now require operative interference. Minor operations are often necessary in the treatment of abscesses, fistulas, and extra-articular foci, which are rendered more safe since the advent of improved antiseptic and aseptic methods. Of the various operations in use, may be mentioned curetage, excision of osseous foci (extra-articular), arthrectomy, excision, and amputation.

Curetage.—After repeated aspiration and injection with iodoform emulsion have failed in the treatment of cold abscesses, or there is danger of rupture or signs of a mixed infection taking place, the abscess should be incised, the walls of the cavity removed by a blunt curet, and the cavity packed with iodoform gauze. Persistent sinuses may be closed by the removal of the indolent granulations and fibrous tissue lining the cavity by means of curetage.

Excision of Osseous Foci.—There has been a tendency of late to operate, in tuberculous diseases of the joints, as soon as the diagnosis is made and the position of the osseous focus definitely located. While the x-ray photograph does not show the presence of an osseous focus until it has reached a considerable size, yet certain static changes may take place in the neighboring bone, as is sometimes seen in the neck of the femur when osseous foci are present, which, combined with the clinical signs, may lead to definite localization. By early operation the focus may be thoroughly removed with the gouge, curet, and chisel. If the disease is extra-articular, early cure should result. The more frequently operations are thus performed, the greater chance there will be that the joint has not become involved, and the period

of convalescence will be materially shortened. If the joint has become infected, no further harm can be done by early exploratory operation. Abscesses form in a large number of cases that are treated by conservative means. This would be avoided by early operation, and if they were already present, there can be no doubt that the termination of the active stage of the disease would be materially hastened by measures that could be used at the time of the exploratory operation.

Arthrectomy or Erasion.—Arthrectomy is an operation of election during the early stage of the disease after the joint has become involved. By this operation attempts are made to remove all diseased structures, particularly the entire synovial membrane and the area of bone surrounding the osseous focus. All healthy portions are left intact. The aim of the operation is to retain good structures, to hasten recovery, and to avoid if possible the deformity, shortening, and partial loss of function which follow all excisions. The operation is to a certain extent successful, as it undoubtedly hastens recovery and prevents the shortening, probable ankylosis, and possible flail joint incident to excision. Very often, however, ankylosis and certain contractures occur which later may require excision. The mortality of arthrectomy is not so great as excision. In children arthrectomy should be performed rather than excision on account of not interfering with the epiphyses.

Excision.—The operation of excision is the one of choice in adults when it is desirable to remove as much as possible of the tuberculous disease without amputation, when time is of importance, when there is mixed infection of the joint with symptoms of systemic infection, and when bony union is desirable. Excision is also performed for flexion, contractures, and all lateral and antero-posterior deformities occurring with ankylosis. The mortality rate is higher than that of arthrectomy and increases with the age of the individual.

Amputation.—Amputation is indicated in old persons with whom the period of convalescence is of paramount importance, in cases in which there is rapidly progressing or extensive phthisis, amyloid degeneration, mixed infection with signs of marked constitutional disturbance, and in cases of marked general weakness.

CHAPTER III.

GENERAL CLASSIFICATION AND GENERAL STATISTICS OF DEFORMITY.

Orthopedic affections may be looked at in any one of three ways, and accordingly a topographic, a pathologic, or an anatomic-pathologic arrangement may be adopted.

The first, or topographic arrangement, is the one usually employed by systematic writers, and the deformities are taken up *seriatim* as they affect the different portions of the body: the head, neck, trunk, upper extremity, lower extremity, etc.

The second, or pathologic arrangement, offers certain advantages, since it gives a clue to the cause and nature of the affections. Thus we have the division into acquired deformities and congenital deformities, and a subdivision of the acquired deformities into three classes as they arise from causes directly, indirectly, or both directly and indirectly, affecting the articulations.

The third, or anatomic-pathologic arrangement, is the one here presented as being the most scientific and satisfactory. The subject is divided into six parts, the affections being classed as they are deformities dependent on: (I) Lesions of bone; (II) lesions of synovial membrane; (III) lesions of cerebro-spinal system; (IV) impaired nutrition, or diathesis; (V) embryonic disease or disturbances of development; (VI) accident or traumatism. These six classes are divided, and are again subdivided into the individual affections. It is not presented as a perfect arrangement, but it is the one the writer has found most convenient in teaching.

The subject may best be divided into two parts, (1) as to general orthopedics, and (2) as to special affections.

CLASSIFICATION OF DISEASES BELONGING TO THE DEPARTMENT OF ORTHOPEDIC SURGERY.

Deformities dependent on	CLASS I. Lesions of bone.	Tubercular Osteitis	{	Pott's disease.			
				Sacro-iliac disease.			
				Hip-joint disease.			
				Knee-joint disease.			
				Ankle-joint disease.			
				Other major articulations.			
	CLASS II. Lesions of synovial membrane.	Infectious or malignant diseases	{	Osteomyelitis.			
				Typhoid.			
				Sarcoma.			
				Carcinoma.			
				CLASS III. Lesions of cerebrospinal system.	Ankylosis.	{	Acute serous.
							Chronic serous.
	Intermittent joint hydrops.						
	Lateral curvature.						
	Infantile spinal paralysis.						
	Infantile cerebral paralysis.						
	CLASS IV. Impaired nutrition, or diathesis.	Paralyses	{	Other paralyses.			
				Torticollis.			
				CLASS V. Embryonic disease or disturbances of development.	Spasms	{	Neuropathic affections.
							Unilateral development.
Knock-knee.							
Bow-legs.							
Curvatures of diaphyses.							
Tardy syphilis of the bones.							
CLASS VI. Accident or traumatism.	Syphilis.....	{	Osteomalacia.				
			Osteitis deformans.				
			Fragilitas osseum.				
			Club-foot.				
			Dislocations of articulations.				
			Perverted development.				
	Inflammation.....	{	Tendon.				
			Cartilage.				
			Irreducible.				
			Ununited.				
			Muscular tissue.				
			Tendons.				

GENERAL STATISTICS OF DEFORMITY.

The great frequency of deformity is not generally appreciated by the laity or the profession, since many distortions are skilfully concealed by the sufferers.

The statement of Schrauth that there were 25,000 deformed in Bavaria, and the estimate by Werner that there were, in 1860, 56,000 cases of scoliosis in Prussia, has recently been emphasized by the statement of Hoffa, computed from the government statistics of Germany, that there were 500,000 deformed

persons in the empire. The census of England and Wales classes 409,207 persons as deformed, of which number 90,277 were in London. It has been estimated that there are in the United States alone 30,000 persons who spend from twenty to forty years of their lives in rolling chairs.

In order that statistics may be of any value to the surgeon there must be a large number, and they must be arranged according to the individual diseases.

Statistics upon deformity have been collected in England by Tamplin, in France by Duval, in Russia by Phillips, and in Germany by Hoffa, and we have these for comparison.

From the surgical clinics of Munich, Hoffa has compiled the following: In 116,978 cases of disease between 1879 and 1889 at the Surgical Polyclinic there were 67,919 surgical cases, of which 1444 were deformities, or 2.13 per cent. The age at which the deformities occurred is well shown in the following table from Hoffa:

0-10 years,.....	602	41.68 per cent.	40-50 years,.....	54	3.74 per cent.
10-20 "	481	32.32 "	50-60 "	30	2.08 "
20-30 "	182	12.61 "	60-70 "	28	1.59 "
30-40 "	70	4.84 "	70-80 "	2	0.14 "

As to the relative frequency of congenital and acquired deformity, out of 1325 cases there were 150 congenital, 11.3 per cent., and 1175 acquired, 88.7 per cent.

In compiling the individual affections Hoffa found the relative frequency to be as follows:

	CASES.	PERCENTAGE OF DEFORMITIES.
Torticollis,.....	7	0.49 per cent.
Scoliosis,.....	399	27.63 "
Rachitic kyphosis, ...	39	2.07 "
Tuberculous kyphosis,.....	142	9.83 "
Club-hand,.....	1	0.07 "
Dupuytren's contraction,.....	23	1.59 "
Congenital dislocation of the hip,.....	7	0.49 "
Genu valgum,.....	119	8.24 "
Genu varum,.....	3	0.21 "
Rachitic deformities of the lower extremities,.....	107	7.41 "
Pes calcaneus,.....	9	0.62 "
Pes equinus,.....	52	3.60 "
Pes equinovarus,.....	171	11.84 "
Pes valgus,.....	338	23.41 "
Hallux valgus,.....	27	1.87 "

In order to determine the relative frequency of deformity in this city I collected in my first edition records from the hospital of the University of Pennsylvania for ten years, from 1884 to 1894, and to these I have added the records for the next succeeding ten years, making twenty years, from 1884 to 1904.

From these records I have found that in 5680 orthopedic cases there existed: Pott's disease, 492; hip disease, 506; knee-joint disease, 104; ankle-joint disease, 44; shoulder-joint disease, 7; elbow-joint disease, 20; wrist-joint disease, 10; lateral curvature, 293; knock-knee, 77; bow-legs, 169; club-foot, 318; and infantile paralysis, 162.

The importance of statistics upon the subject of tuberculosis has led me to classify 1000 cases of tuberculosis of the bones and joints taken from the records of the Hospital of the University of Pennsylvania and of the Philadelphia Polyclinic Hospital. These will be considered under the following heads: traumatism, distribution, side affected, sex, age of incipency, and mortality.

In 298 cases of these 1000 cases the direct predisposing cause of the local disease appeared to be due to local injury.

The distribution of the affection was as follows:

Vertebras,.....	416	41.6 per cent.
Hip-joint,.....	421	42.1 "
Knee-joint,.....	103	10.3 "
Ankle-joint,.....	33	3.3 "
Shoulder-joint,.....	2	0.8 "
Elbow-joint,.....	17	1.7 "
Wrist-joint,.....	8	0.2 "

The side affected was as follows:

	RIGHT.		LEFT.	
Hip,.....	195	52.7 per cent.	175	47.3 per cent.
Knee-joint,.....	42	46.1 "	49	53.9 "
Ankle-joint,.....	26	83.9 "	5	16.1 "
Shoulder-joint,.....	-	-	2	100.0 "
Elbow-joint,.....	7	53.8 "	6	46.2 "
Wrist-joint,.....	2	25.0 "	6	75.0 "
Total,.....	272	52.8 "	243	47.2 "

The sex was as follows:

	MALE.		FEMALE.	
Vertebras,.....	222	54.5 per cent.	185	45.5 per cent.
Hip-joint,.....	247	58.7 “	174	41.3 “
Knee-joint,.....	65	63.1 “	38	36.9 “
Ankle-joint,.....	16	48.5 “	17	51.5 “
Shoulder-joint,.....	..	..	2	100.0 “
Elbow-joint,.....	11	64.7 “	6	35.3 “
Wrist-joint,.....	3	37.5 “	5	62.5 “
Total,.....	564	58.9 “	427	41.1 “

The age at which application for treatment was made was as follows:

YEARS.	VERTEBRAS.	HIP.	KNEE.	ANKLE.	SHOULDER.	ELBOW.	WRIST.
0-5,.....	172	135	28	14	..	..	..
5-10,.....	100	134	29	6	..	3	..
10-15,.....	50	77	15	3	2	6	3
15-20,.....	29	29	4	..	..	5	2
20-25,.....	33	17	5	1	..	2	2
25-30,.....	17	13	7	2	..	..	..
30-35,.....	3	7	4	2	..	..	..
35-40,.....	7	4	3	1	..	..	..
40-45,.....	5	3	2	..	..	1	..
45-50,.....	3	2	2	..	..	..	..
50-55,.....	..	..	3	..	..	..	1
55-60,.....	..	..	..	1	..	..	..
60-65,.....	..	1	1	..	..	..	..
Total,.....	419	421	103	30	2	17	8

Out of the 1000 cases, the rate of mortality was 34, of which 17 died under conservative treatment, and 17 following operation.

It will be especially noted that the age of incipency increases up to the seventh year, when there is a decided fall, and again an increase.

From other sources I have collected 7243 cases, which, together with 1183 cases previously collected by myself, make 8426 cases of joint tuberculosis. Of the 7243 cases collected from other sources, none show the entire relative proportion, and only two of them are larger than my own. Statistics appear to be unreliable chiefly because of extraneous influences tending to separate the cases. The following table is given to show the variation which occurs in Edinburgh, Vienna, Philadelphia, and other cities:

	GIBNEY.	BOSTON CHILDREN'S HOSPITAL.	NEW YORK ORTHOPEDIC HOSPITAL, 1884-86.	ALBERT, VIENNA, 1892.	JAMES, EDINBURGH, 1888.	JUDSON.	MENZEL AND BILLROTH.	SCHULLER AND SOGIN.	YOUNG, PHILADELPHIA, 1904.	TOTAL.
Hip,.....	271	220	1178	132	124	577	187	69	506	3264
Knee,.....	103	64	309	215	161	181	235	157	104	1520
Ankle,.....	31	36	83	200	88	..	145	51	44	678
				and foot.						
Shoulder,...	..	3	11	..	21	6	..	18	7	66
Elbow,.....	..	1	11	119	91	8	..	55	20	303
Wrist,.....	..	1	7	74	45	..	..	27	10	164
				and hand.						
Vertebra,....	..	202	1024	No Record.	No Record.	..	702	No Record.	492	2420
Total, ..	405	527	2623	740	530	772	1269	377	1183	8426

The association of joint tuberculosis with pulmonary tuberculosis is difficult to determine, since the records are not satisfactory. In investigating this subject I have been kindly aided by Dr. Lawrason Brown. From the statistics

of the Adirondack Cottage Sanatorium, Saranac Lake, N. Y., it was found that in 2000 cases there were 10 cases of tuberculous disease of the joints. These illustrate the development of joint tuberculosis in those suffering from chronic pulmonary tuberculosis. They were distributed as follows: hip, 5; knee, 3; elbow, 1; and wrist, 1.

These statistics do not show the real frequency of such affections, as only very carefully selected cases are accepted at the Sanatorium, but they show in a degree the development of joint tuberculosis in those afflicted with pulmonary disease.

Only one of these cases had laryngitis. It is my observation that this affection is very rarely associated with joint tuberculosis. That it is very common among Indians is a well-known fact, but joint tuberculosis occurring in Indians suffering from laryngitis is very rare.

Dr. Hrdlicka, of the Smithsonian Institute, U. S. National Museum, who has made a special study of tuberculosis among the Indian tribes, has given me the following valuable information as a result of his researches. In studying a large number of skeletons of Indians of a very early period, before the advent of the whites, there was not a single instance of tuberculous lesion of the bone in a plainly discernible form, nor were any lesions that were found of such a nature as even to suggest tuberculosis as a predisposing cause. Among modern Indians, however, pulmonary and glandular tuberculosis are frequent, and tuberculosis of the knee and also of the hip have been met in certain localities. Among the Mescalero Apaches, in New Mexico, deformities have been noted which were probably a sequel to hip disease. Six or seven such cases have recently come under the observation of Dr. Hrdlicka. Among some of the Sioux tribes in the colder regions, and also among the Nez Perce, tuberculosis in all its forms is prevalent.

Joint tuberculosis is very prevalent in the large cities of this country, but in certain sections it is practically unknown among the natives, as in the pine district of Georgia, the desert region of Arizona, and the forest sections of the Adirondacks.

CHAPTER IV.

GENERAL SYMPTOMS, DIAGNOSIS, AND PROGNOSIS OF DEFORMITY.

Under the general subject of symptoms must be considered not only those actual deformities of the parts which are described under the special sections of this work, but more particularly the effect upon the individual physically, mentally, and in his relation to his environment.

On account of their deformities many people are rendered useless to the world and become a burden to the community. In countries where military service is compulsory the difficulty of utilizing deformed persons is most apparent. Unfortunately deformity occurs most frequently among the poorer classes, adding a heavier burden to their overtaxed condition. The effect of a deformed body upon the individual thus afflicted cannot readily be understood by normal persons. Many of these afflicted ones dwell in solitude, like the black dwarf of Scott, haunted by the consciousness of their own deformity. The more ancient writers always considered that deformed persons commonly strove to compensate themselves in some way for that of which nature had deprived them, and they are described by these older writers, and by Bacon, Shakespeare, and their contemporaries, as being generally void of natural affection, inclined to revenge, and with their natural inclinations not obscured by discipline and virtue. They are supposed to carry about within themselves the elements which induce contempt and derision, and they make a constant effort to deliver themselves from this contumely. From this effort they gradually become bold and unscrupulous, avaricious, and vindictive.

These traits which have been attributed to the deformed are not so commonly credited to them in the present day, since the deformities themselves are not permitted to increase to so great a degree, and the attitude of the world toward the deformed is not what it was in centuries past. One meets many characters like Lady Joan in Scott's "Quentin Durward," but there are few diabolical Quilps, such as the dwarf so vividly portrayed by Dickens.

The effect of deformity upon the intellect, and especially the psychic pain which deformed persons experience, is well shown in their physiognomy. This

has been referred to by many writers. It affects equally the high in station and the low, the rich and the poor, without respect to persons. The greatest of all English writers has well described this mental suffering in many of his characters, notably the Duke of Gloucester:

“Love forswore me in my mother’s womb:
And, for I should not deal in her soft laws,
She did corrupt frail nature with some bribe
To shrink mine arm up like some wither’d shrub;
To make an envious mountain on my back,
Where sits deformity to mock my body;
To shape my legs of an unequal size;
To disproportion me in every part;
Like to a chaos, or an unlick’d bear-whelp
That carries no impression like the dam.”

—*Henry VI, Part 3d, Act III, Scene II.*

One facetious English writer, Hay, in his “*Essay on Deformity of the Human Body*,” sensibly vindicates the deformed, to which class he himself belonged, against the stigma which has been placed upon them. That deformity of the body does not necessarily interfere with greatness of intellect or achievement of great deeds is evidenced among the names of great men who have been deformed. Æsop, Alexander the Great, Socrates, and Agesilaus are representatives of the ancients, and Pope, Scott, Talleyrand, Byron, Lord Burleigh, Mendelssohn, and many others in later times, are examples of greatness achieved in spite of bodily deformity.

The sole instance of the mention of a deformed woman in the classic poets is that of Cutilla, a centenarian, to be found in Pliny and Juvenal.

Attitude in Deformity.—The peculiar attitudes assumed by individuals suffering from various deformities are so characteristic that they may be considered almost pathognomonic.

In children suffering from acute epiphysitis of the hip the attitude upon the back and with the thigh flexed and rotated outward is so typical that the affection could be diagnosed by inspection alone.

In acute lumbar abscess the position of the child resting upon all four extremities in the quadrupedal position is never seen in any other intra-abdominal tumors.

The attitude in infantile spinal palsy is typical and differs markedly from the peculiar position assumed by a child suffering from lateral curvature resulting from pleuropneumonia.

In cerebral palsy the idiotic expression, the rigidity of the extremities, and the deformed feet would at once lead to a correct opinion as to the condition present.

In hip-joint disease the child stands upon the sound limb with the other one flexed slightly forward and with the body poised over the affected limb in such a manner as to produce a characteristic attitude.

In cervical caries the head is frequently held to one side and supported by one or both hands in a fixed position, the attitude of which is so characteristic that it could not be confounded with any other condition.

In progressive muscular atrophy the marked lordosis, the enlarged calf muscles, and the effort which the individual makes to balance himself produce an attitude which is at once unmistakable from that of any other nervous affection; while in iliac abscess the position of the child in standing with the thigh flexed and heel elevated, together with the presence of a kyphosis, is one which could not be mistaken for any other condition.

Diagnosis.

For the general diagnosis of deformity, bacteriology, the Röntgen ray, and accurate mensuration are employed as well as all the methods used in physical diagnosis.

Many conditions may be recognized by inspection alone, but in all cases the examination should be most thorough, as mistakes usually occur through incomplete examination. The upper part of the body may be inspected first, and this may be covered with clothing while the lower part is inspected. In young children the complete exposure of the body is the most satisfactory method of making a thorough examination. In all cases of joint disease the entire extremity should be carefully examined and should be compared with the opposite limb.

Bacteriology.—The importance of making bacteriologic tests in all diseases of the joints cannot be overestimated, since in many instances a correct diagnosis is otherwise impossible. These tests should be repeated from time to time.

Mensuration.—For the purpose of recording the condition present many different methods, amounting at the present time to at least sixty, are employed. These include methods from the most simple free-hand drawing to life-size tracings taken with elaborate machines. The most useful tool for making outlines is the lead tape, a narrow strip of solder by which the outlines can be



FIG. 69.—ATTITUDE IN ACUTE EPIPHYSITIS OF THE HIP.



FIG. 70.—ATTITUDE IN LUMBAR ABSCESS.



FIG. 71.—ATTITUDE IN INFANTILE SPINAL Palsy.



FIG. 72.—ATTITUDE IN LATERAL CURVATURE FROM PLEUROPNEUMONIA.



FIG. 73.—ATTITUDE IN CEREBRAL PALSy. PARALYTIC TYPE.



FIG. 74.—ATTITUDE IN HIP-JOINT DISEASE.



FIG. 75.—ATTITUDE IN CERVICAL CARIES.



FIG. 76.—ATTITUDE IN CERVICAL CARIES.



FIG. 77.—ATTITUDE IN PROGRESSIVE MUSCULAR ATROPHY (Pepper).



FIG. 78.—CONTRACTION OF HIP FROM ILIAC ABSCESS.

accurately traced. Measurements made with the caliper or with the pelvimeter are very valuable and should not be omitted. In order to determine the inequality of the lower extremities special measuring machines have been devised, and the one here figured (Figs. 81 and 82) will be found rapid and useful.

Impressions of the feet, pematograms, should be made for purposes of record, and may be taken singly or they may be taken continuously on a long sheet of paper. There are many different ways of taking these impressions, the simplest of which is to anoint the foot with vaselin, after which it is placed upon a piece of cardboard, thus transferring the impression. A glass plate may be smoked from a candle or lamp and the impression of the foot trans-

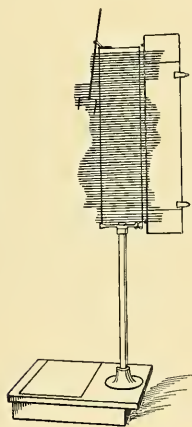


FIG. 79.—ROD SCOLIOSOMETER.

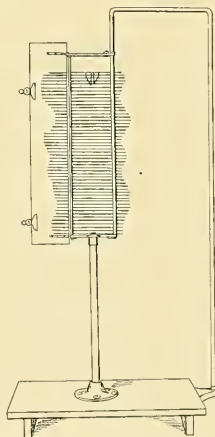


FIG. 80.—ROD SCOLIOSOMETER.

ferred from this to a piece of white cardboard. The patient's foot may be oiled and then placed in a box of lamp-black and the impression transferred to a piece of white cardboard, or else in a box filled with French chalk and the impression then transferred to a piece of black cardboard. The best and most satisfactory method, at the present time, however, was suggested by Freiburg, and consists in covering the foot with a solution of tannic acid from the following formula:

Acid. tannici, ...	gr. xx.
Glycerini, ...	fʒviij.
Aquæ, ...	ad fʒiiij.

The patient then stands upon a piece of cardboard and the outline of the foot

is traced with a pencil. As soon as the impression dries the following solution is applied, to make a permanent ink impression of the foot:

Tr. ferri chlor.,.....	f5iss.
Alcohol,.....	f5xj.
Glycerini,.....	f5j.

Continuous impressions are particularly useful as illustrative of the gait in certain nervous affections. Thus in cerebral palsy the impression of the right foot will sometimes be on the left side of the paper and the impression of the left foot will cross over to the right side of the paper from the overlapping



FIG. 81.—AUTHOR'S MACHINE FOR MEASURING INEQUALITY OF LOWER EXTREMITIES.



FIG. 82.—AUTHOR'S MACHINE FOR MEASURING INEQUALITY OF LOWER EXTREMITIES.

of the legs. The position of the feet in the continuous impressions is also of value as indicating the amount of inversion or eversion of the limbs.

The impression of a normal foot is very difficult to obtain, since the effect of pressure upon the shape of the feet shows itself at a very early age.

A most important manner of obtaining records of deformity is by means of photographs. These should be taken with the part uncovered, and should always be taken in exactly the same manner, the same distance from the camera, and if possible by the same person, so as to eliminate the personal equation. The value of the photographs may be increased by the use of a screen made up of threads placed about one or two inches apart. The patient is placed



FIG. 83.—IMPRESSION OF NORMAL FEET.

on the far side of this screen, and patient and screen are photographed on one plate. Another method may be employed, that of photographing the patient on the one plate and making a second exposure of the screen; or still a third method may be used, of using a screen thrown upon a negative and placing the two negatives together in making the print. Photographs enlarged to

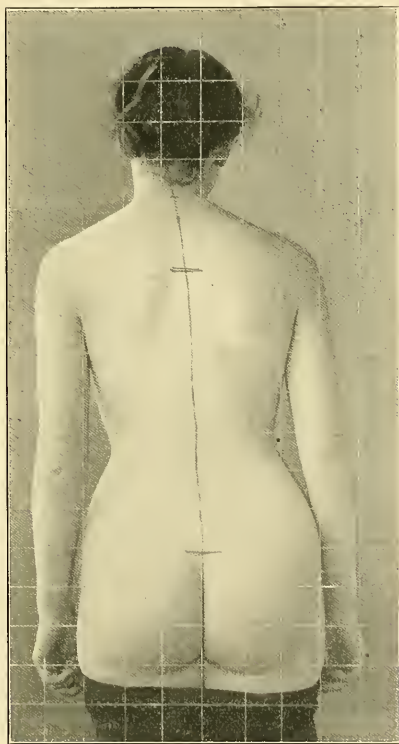


FIG. 84.—SCREEN PHOTO.

life-size are sometimes valuable, particularly where the part is small, as in children.

The discovery of the Röntgen ray and its application to surgery has rendered the diagnosis of many obscure orthopedic affections very simple. In orthopedic practice it is usually best to take a photograph of the corresponding joint

on the opposite side at the same time as that of the diseased joint; and when it is possible it is best to take them upon the same plate, placing the tube midway between the joints. Such photographs as this can readily be compared, and if the parts are held in exactly the same position the diagnosis is rendered easier. To avoid motion of the part and to render the tissues less bulky between the tube and the anterior portion of the joint a compression cylinder may be used to advantage, and the one made in this country is to be recommended. This also has the advantage of concentrating the light and increasing its penetrating power. It is of decided advantage where the deep structures are to be taken. In order to compare the diseased parts with normal conditions it is always best to have convenient photographs of normal joints.

Another very important manner of preserving records is by the use of plaster casts or wax models. The way in which these are taken is the same as that employed by the Italian plaster modelers.

In keeping all records of deformities both in private and public work elaborate printed forms are sometimes used to great advantage, as in this manner important questions are not overlooked in the anamnesis.

Prognosis.

Confirming the opinion of an early writer, Little, it may be truthfully said at the present time that many of the most severe deformities can be cured with less difficulty than any other difficulties or affections which are at all comparable in the amount of mental and bodily suffering involved. The prognosis will depend greatly upon the time when treatment is undertaken, since many deformities are rendered more difficult of treatment by reason of the bony changes which occur. Thus in club-foot, scoliosis, and rachitic deformities the occurrence of permanent bony changes makes the cure much more difficult.

The occurrence of spontaneous cures is exceedingly rare. In club-foot there have been recorded but two cases which have recovered without treatment. One of these was a boy, the son of a miller, in France, reported by Dupuytren, who was induced by his parent to carry a heavy load of grain upon his shoulder and to place his foot in a certain position upon the ground, resulting in a cure by the time he had reached the age of twenty. The other was a negro reported by the writer who suffered from club-foot until he was twenty years of age. From this time until his twenty-sixth year his feet gradually began to turn out, from the natural tendency to flat-foot present in this race, until he finally recovered.



FIG. 85.—NORMAL HIP. X-RAY.



FIG. 86.—NORMAL KNEE. X-RAY.

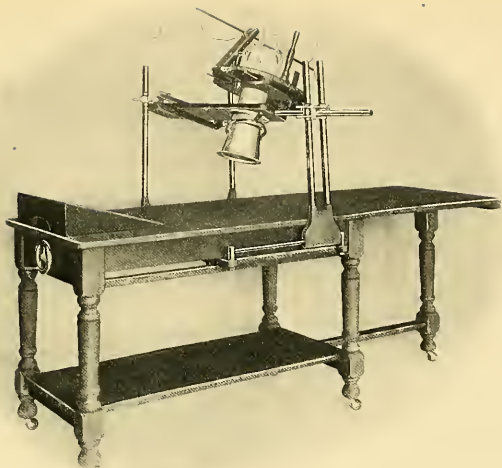


FIG. 87.—KELLY-KOETT MACHINE FOR MAKING X-RAYS, SHOWING COMPRESSION CYLINDER.

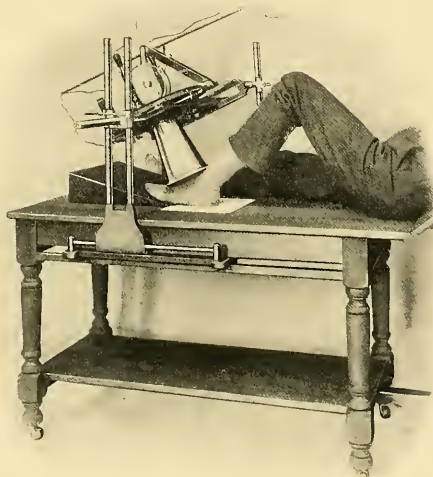


FIG. 88.—KELLY-KOETT MACHINE FOR MAKING X-RAYS APPLIED.

Spontaneous recovery from rachitic deformities sometimes occurs from muscular development while the bones are still soft, but if the disease has reached the hardening process spontaneous recovery is not likely to occur. With the exceptions mentioned, deformity either remains stationary or else becomes gradually worse.

The results of treatment of deformities are astonishing, particularly when surgical operations are first performed, and are followed by thorough orthopedic treatment. Very frequently when the deformity is too severe for a cure to be effected it may yet be so treated that the disease may be checked, and the patient rendered comparatively comfortable.

CHAPTER V.

PROPHYLAXIS AND GENERAL TREATMENT.

More important than the actual treatment of bodily deformities is the prophylaxis, or prevention, by the employment of every means which will improve the physical condition of the patient. Under this title should be included not only the complete hygiene of the individual but the development of the osseous and muscular systems by means of gymnastics and sports. The physical examination of children in public and private schools marks an important advance in this direction. Not only is the child better fitted for its future work by the physical examination, but any early deformity is recognized by the trained examiner and may be corrected before it becomes permanent.

The establishment of public institutions by the State and by private individuals for the correction and treatment of the deformed is characteristic of the progress which has been made in this line. The State Hospitals of New York, Minnesota, and of many other States, are model institutions of their kind, and the private institution, the Widener Home for the Crippled and Deformed, of Philadelphia, erected at a cost of two million dollars by its generous donor, is far superior to anything that has yet been conceived along these lines. Not only are the deformed cared for and treated, but their education and future welfare are insured.

Under the head of prophylaxis we may consider the early treatment of congenital deformities, since this prevents the development of the severer deformities and admits of their correction before they have become extreme.

The greater care and the more extensive knowledge in regard to the treatment of joint disease at the present time prevent the crippling and distressing deformities which were formerly so common in this condition, and where the joint disease cannot be cured the setting of the limb in such a position as to insure its greatest usefulness should be considered under the head of preventive measures. Thus, the knee and hip are set straight, and the elbow and foot are flexed at a right angle.

The prevention of such diseases as are caused by neglect and exposure calls for consideration here. Since a certain number of cases of infantile paraly-

sis are due to the chilling of the surface of the body when the patient is overheated, the prevention of conditions which lead to this result would in many instances forestall the development of this serious condition.

The proper feeding of infants through municipal aid and private charities is of great service in preventing the occurrence of rickets, and at the present time, when rickets is becoming more frequent in the large cities of this country, attention should be directed to this means of prevention. The establishment of modern sanitary farms enables the rich to obtain pure milk, and in this way escape many of the dangers of rickets and of tuberculosis.

The prevention of nervous diseases due to mineral poisons, illuminating gas, and sepsis, should all be considered under the head of preventive medicine.

General Treatment.

In addition to the local and special treatment, which will be described later, it is necessary to take into consideration the constitutional treatment of the deformed. This includes everything which will improve the physical condition of the afflicted, and especially as to diet, exposure to sunlight, and change of residence, together with such medical and general treatment as may be indicated by the special requirements of the case.

Diet.—The study of the proper diet of infancy and childhood has received so much attention of late that it is only necessary to call attention to the importance of securing a proper diet for those who are deformed.

Sunlight.—In no class of diseases is exposure to sunlight so important as in the treatment of tuberculous joint disease, which is productive of such a large number of deformities. So important is the use of solariums that many institutions at the present time have sun-parlors attached to the orthopedic wards, and the beneficial effects of this form of treatment are so marked as to attract the attention of all who are interested in the subject.

Change of Residence.—A change of residence to the seashore or mountains is often most valuable to give that impetus which is necessary for the cure of cases of joint tuberculosis. So important is a residence at the seashore for part of the year that public institutions have been established for the care of the indigent, and the marked benefit to these cases can scarcely be overestimated. Personally I have seen cases which would otherwise have been fatal make a good recovery within two or three months. When there is a nervous element in the patient, a change to a higher altitude is frequently

more beneficial than to the seashore, or a change to the mountains may succeed a short stay at the seashore.

Medical Treatment.—The medical treatment includes the use of tonics, particularly the salts of iron, with the use of hypophosphites. In tuberculous cases cod-liver oil is found to be of great value, and in some joint lesions the use of mineral waters or a residence at a mineral spring is found to be of signal benefit.

Electricity.—The application of electricity in the treatment of orthopedic cases should not be neglected. The faradic current will be found to be more useful than the galvanic, and the frequently interrupted should be preferably employed for the general nutrition of the parts. The local application of either the faradic or galvanic current to the motor points is of great service in many orthopedic cases. The special application of electricity to the individual affections will be dealt with at greater length under the various subjects. Occasionally galvanopuncture of the muscles by means of a needle is of value.

Gymnastics.—The conflicting discussions which prevailed during the past century have now been settled by the general adoption of medical gymnastics in the treatment of orthopedic affections. Especially valuable is the method originated by Ling, known as the Swedish system. The practice of Swedish gymnastics today is based largely upon empiricism, since many of the theories held by the founder are untenable.

Sequence of movement is the most important feature of this system, using simple movements followed by combinations of movements, complex movements, and finally exercises which include the general action of the entire body. Of the four special divisions of the Swedish system, the pedagogic or school gymnastics, military gymnastics, medical gymnastics, and esthetic gymnastics, we are concerned only with the third group. In orthopedic treatment the medico-gymnastic exercises include respiratory exercises, general health exercises, and exercises which are used in the correction of lateral curvature. The proper order in which the exercises should be given is also of importance, and the following order is the one which is most generally employed, being subject to modifications in certain cases: a respiratory movement is first given, which is followed by a movement of the lower extremities and of the upper extremities; then follows a movement of the abdomen and trunk, followed by a movement of the lower extremities, and finally ending with a respiratory movement. This practice of beginning with a respiratory movement, leading up to more violent movements of the trunk, and gradually returning to the respiratory movement,

with which to end, is of advantage in gradually allowing the accelerated action of the heart to become slow, and also to permit the gradual lessening of the perspiration caused by the exercises. The system also requires that each movement shall be taken from a starting position. The movement should be carefully carried out from this first position and the body returned to the same position. There are five fundamental positions—standing, sitting, lying, hanging, and kneeling.

The movements are either active or passive, and in many of the medical gymnastics they are subjectively passive, the exercises being carried out by the

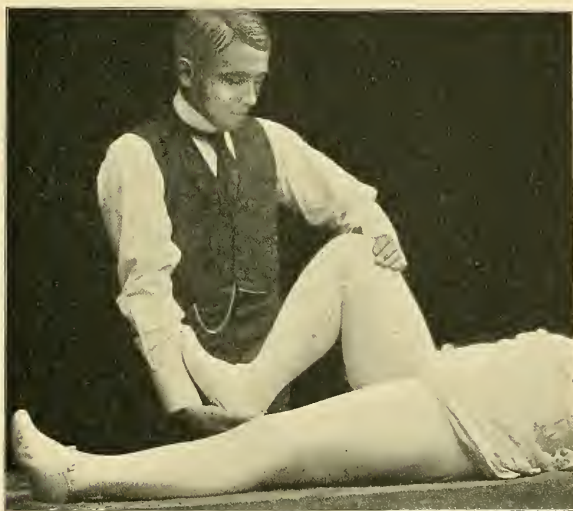


FIG. 89.—PASSIVE FLEXION AND EXTENSION.

manipulator. All of the exercises required for the treatment of deformities are special, and should be prescribed by the surgeon. Most of the systems which are usually employed in the work of general development are not suited to orthopedic work, since they employ the muscles on both sides of the body and cannot be adapted to the treatment of special deformities. The subject of physical development is so extensive that it is impossible to deal with it in a general way, and the reader is referred to Cohen's "Physiologic Therapeutics," volume VII, and Keating's "Cyclopedia of the Diseases of Children," volume IV.

Mechanical Gymnastics.—The introduction of machines for physical development has greatly enlarged the scope of this department, and has produced a branch of gymnastic treatment which may be spoken of as the medico-mechanic. Elaborate machines covering an extensive field have been provided in this country by the Sargent system, and in Europe by the Zander system. These differ widely in appearance and use. The Sargent apparatus is adapted to the development of any part of the body, from a single finger to the muscles of the entire back. When used in gymnasiums, this system is



FIG. 90.—PASSIVE ROTATION.

employed only after a thorough physical examination of each individual, and the special prescription of exercises to overcome particular defects. For orthopedic treatment the special exercises are prescribed by the surgeon according to the development desired for the individual condition.

The Zander machines include two forms, those which are intended for the application of massage and those which are used for the production of movements, passive, active-passive, and resistive. They are very elaborate, and include machines for the treatment of every portion of the body, being

run by motive power. In this respect they differ from the Sargent apparatus, which is manipulated by the patient.

From these two types of machines numerous modifications have been devised both in this country and abroad, so that the number in use at the present time is legion. A special form of apparatus has of late been contrived which may be described as the pendulum apparatus, the motive power being the individual and the resistance being by means of weights, and the action is that of a pendulum. Appliances have been manufactured upon this principle by Beely, Hoffa, and others.

Special machines have been devised for the correction of deformity, especially for lateral curvature of the spine. These may all be included under two types—the Hoffa machine, combining self-suspension with local pressure, and the Beely machine, which omits the suspension and applies the pressure by means of bands and straps. The best representative type of the correcting machine is the “Weigel-Hoffa,” which is used for correcting lateral curvature.

The most recent therapeutic agent which has been introduced into orthopedic practice is vibration. This may be given by hand-power or by electricity. From one to two

thousand blows may be given a minute, and the accuracy and evenness of these movements are much greater than can be given by the human hand.

Massage.—A very valuable form of passive exercises by systematic manual manipulation of the affected part for therapeutic purposes is known as massage. Scientifically applied it influences the muscular, nervous, circulatory, and digestive systems. It is most valuable in orthopedic practice to prevent atrophy

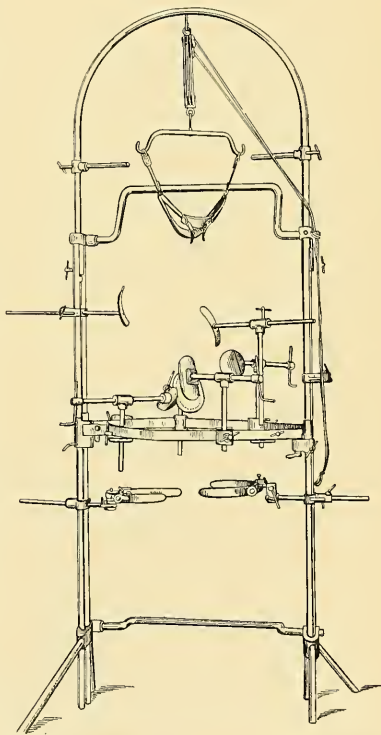


FIG. 91.—WEIGEL-HOFFA CORRECTING MACHINE FOR LATERAL CURVATURE.

of the muscles, to develop muscular power, to stimulate nerve action, and as a sedative to the central nervous system. Properly applied it is an art, and has a most beneficial effect, but improperly applied it has a very deleterious effect upon the patient. For this reason it should be very carefully prescribed by the surgeon as to the movements to be given, the method, time, etc. It is most skilfully applied by a warm, dry hand, without any lubricant.

Five different movements are recognized—effleurage, pétrissage, friction, tapotement, and vibration. Under these heads may be included all movements which are given under the general term of massage, although some authorities have subdivided them into more than sixty heads.

By effleurage is meant a rhythmic stroking of the part, employing the flat of the hand, the edge of the hand, the thumbs, the thumbs and finger-tips, according to indications. It is always applied with a centripetal movement and a certain amount of pressure is used. The movements should be given rhythmically, beginning slowly, increasing the speed somewhat, and terminating with a slow movement.

The movement known as pétrissage consists in grasping and kneading the part by alternately tightening and loosening the grasp, and lifting and alternately rubbing with the flat of the hand, keeping the fingers close together and moving the skin beneath the hand. The special movements included under this division are varied to suit the individual requirements, being described as fulling, rolling, wringing, fist-kneading, etc. Pétrissage is the most important movement used in general massage, producing a direct stimulation to the muscles, increasing the venous and lymphatic circulation, and indirectly affecting the articular circulation.

The movement known as friction is applied with the thumb or tips of the fingers in small circles,—centripetal rubbings,—a certain amount of pressure being used throughout the movement. It is most valuable in chronic and subacute affections for the purpose of removing exudates.

Tapotement, or tapping, consists in a series of rapid percussions with the finger-tips, percussion; with the edge of the hand, hacking; with the flat of the hand (*main plat*), slapping; with the closed hand (*à poing ferme*); and with the surface of the hand hollowed out like a cup (*à air imprime*), cup-hand slapping. Tapotement with the knuckles is occasionally employed. The application of tapotement is limited. The slapping movements are used to stimulate the superficial nerves, and the hacking movement is applied to the muscles throughout their entire length.



FIG. 92.—EFFLEURAGE OF SPINE.

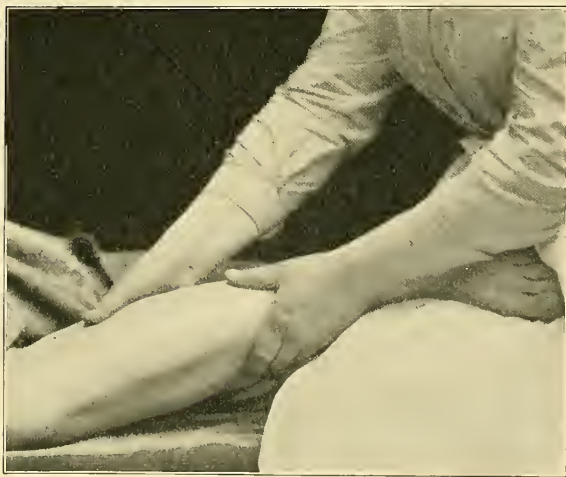


FIG. 93.—PÉTRISSAGE.



FIG. 94.—FRICTION.

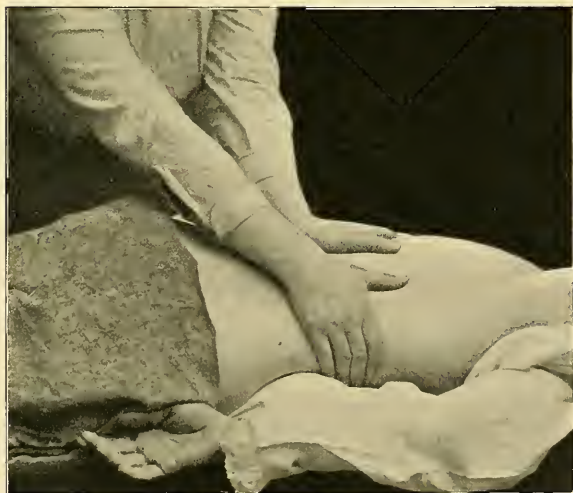


FIG. 95.—THUMB SEPARATING ON BACK.

The movement of vibration is a rapid, shaking movement with the flat of the hand or with the fingers extended on the part. It is the only movement which can be applied with a machine as well as with the hand.

Massage should be given only once a day and should at first be applied about twenty minutes, the time being gradually extended to forty minutes. This rule holds good ordinarily, but if it is a local treatment, as for a joint, it may be employed two or three times daily for from five to ten minutes, and where there is much pain following the manipulations, it would have to be given

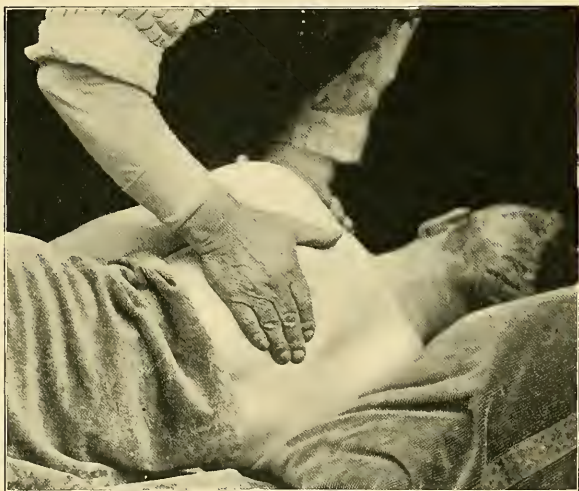


FIG. 96.—FLAT-HAND KNEADING.

only once in two or three days. It should not be given for about two hours before, and three hours after, a meal.

Heat.—The application of hot air is valuable in the treatment of joint affections, and may be applied by inclosing the part in a superheated chamber. The part must be carefully wrapped in lint and toweling to absorb the moisture which is given off. The apparatus should be lined with asbestos and the part suspended upon a flat form of muslin or asbestos. Special apparatus for the local application of heat has been devised, notably the Tellerman-Sheffield and the Frazier-Lentz apparatus. The principle is the same in any such apparatus, the part requiring treatment being inclosed in the superheated chamber, the temperature being generated by gas or oil, and being carefully regulated

by means of a thermometer. In the Frazier-Lentz apparatus the temperature may be carried to 350° F., but it is not necessary to employ so extreme a degree of heat in order to accomplish satisfactory results. The effect of the application of hot air is to produce a local sweating and congestion of the part. The temperature should be raised gradually, maintained at the maximum for some time, and allowed gradually to cool, the amount of time consumed in the entire process being from twenty to forty minutes. If the parts are properly covered and the temperature is not excessive, there should be but little danger of burning the part; and if applied carefully, the hot-air treatment is frequently very

beneficial, and burns seldom occur. This form of treatment is most useful in traumatic arthritis, rheumatoid arthritis, sprains, chronic articular rheumatism, and septic arthritis. In many chronic conditions the results of the application of heat are increased by the administration of massage after the application of the heat.

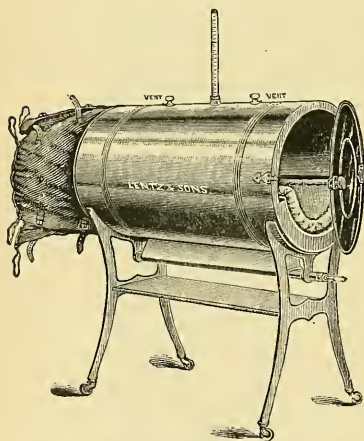


FIG. 97.—FRAZIER-LENTZ HOT-AIR APPARATUS.

Local Treatment.

The local treatment of orthopedic affections consists in the application of apparatus and appliances, and in orthopedic surgical operations.

In prescribing apparatus for patients it is very important that very careful and accurate outlines of the measurements should be secured.

These are taken in several different ways by the practical surgeon. For example, in taking the outlines for the measurements of bow-leg braces, some employ a drawing showing the circumference of the parts. In others the outline represents the side view of the apparatus to be used, while a third form employed is to take a drawing of the elevation of the parts viewed from the front. When the deformity is great, the outlines of the limbs traced upon paper is of service to the instrument-maker.

In taking outlines for spine braces and outlines of parts that are greatly deformed the lead strip is most frequently employed. This is applied directly to the deformity, and the outline is then drawn on cardboard or pressboard.

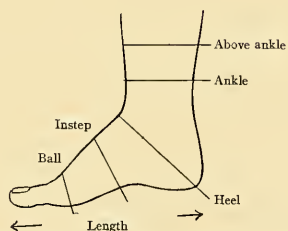
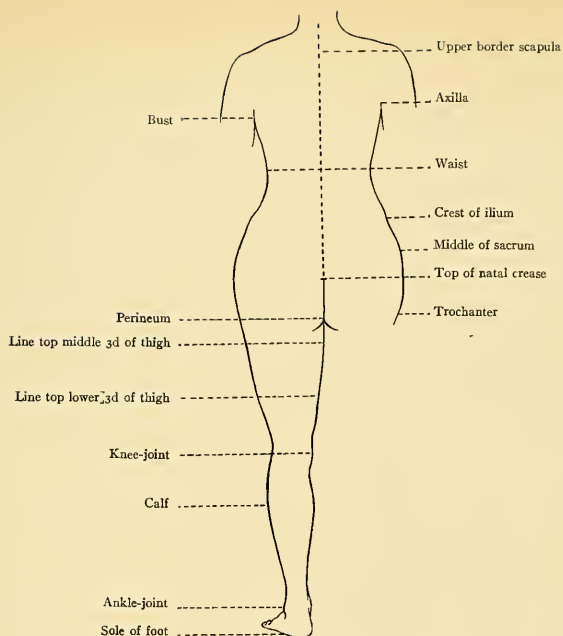


FIG. 98.—OUTLINE FOR MEASUREMENTS OF SPINAL APPARATUS AND LOWER EXTREMITY.

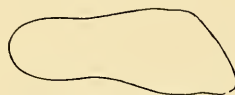


FIG. 99.—OUTLINE OF SOLE.

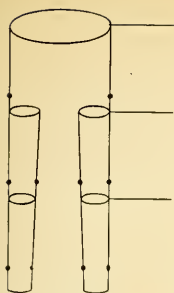


FIG. 100.—OUTLINE FOR BOW-LEGS BRACES.

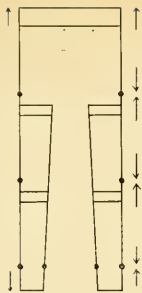


FIG. 101.—OUTLINE FOR BOW-LEGS BRACES.



FIG. 102.—OUTLINE FOR BOW-LEGS BRACES.



FIG. 103.—OUTLINE FOR BOW-LEGS.

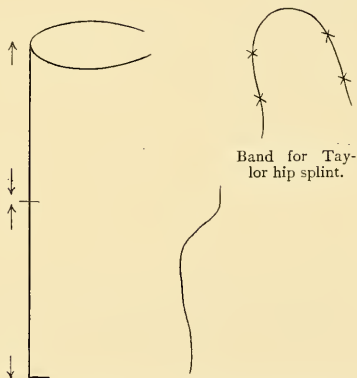


FIG. 105.—OUTLINE FOR TAYLOR HIP SPLINT.

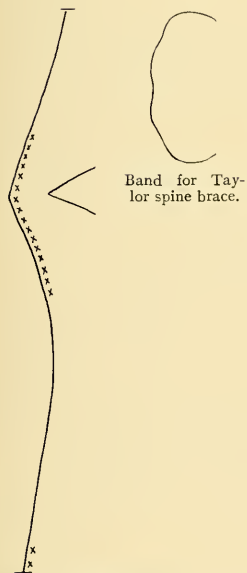


FIG. 104.—OUTLINE FOR TAYLOR SPINE BRACE.

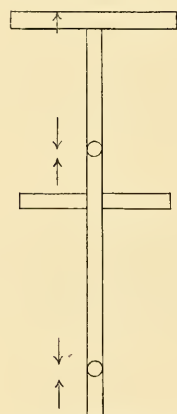


FIG. 107.—MEASUREMENT FOR LEG BRACE.

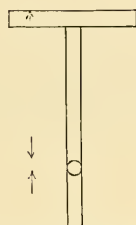


FIG. 108.—OUTLINE FOR ANKLE SUPPORT.



FIG. 106.—MEASUREMENT FOR THOMAS HIP SPLINT.

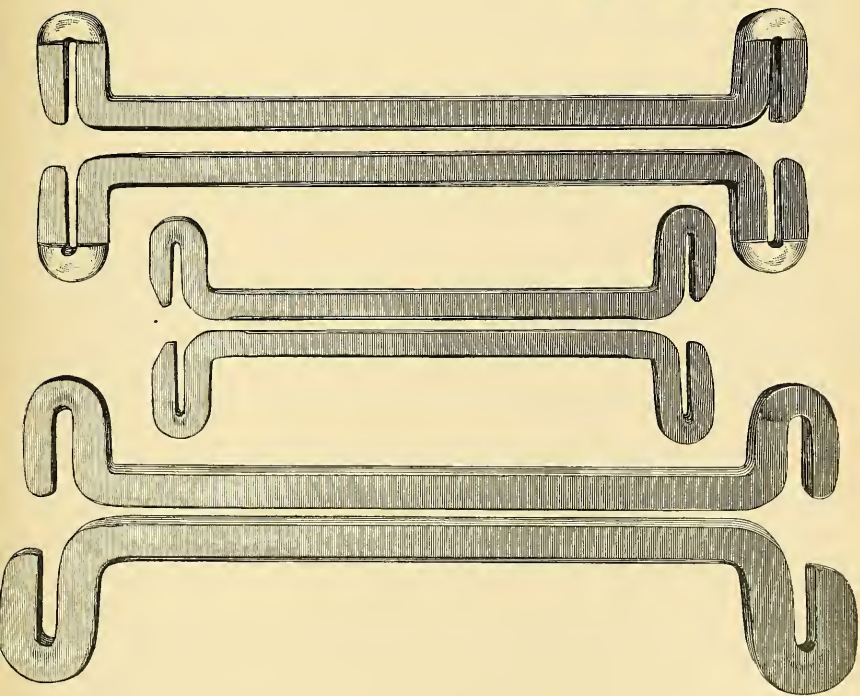


FIG. 109.—BENDING IRONS.

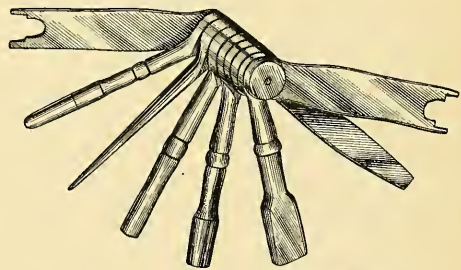


FIG. 110.—PORTABLE SET.

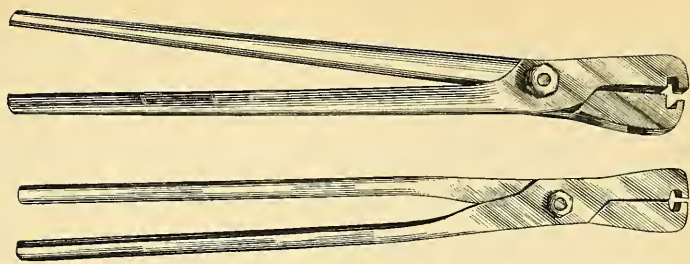


FIG. 111.—BENDING FORCEPS.

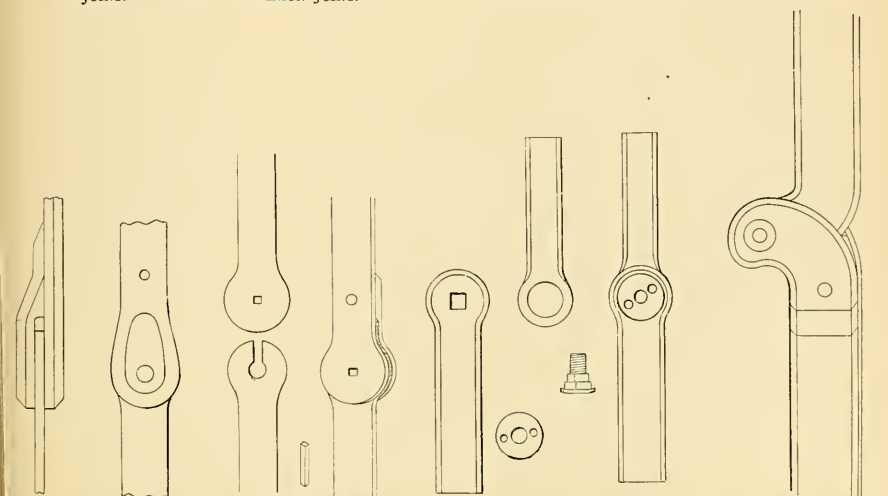
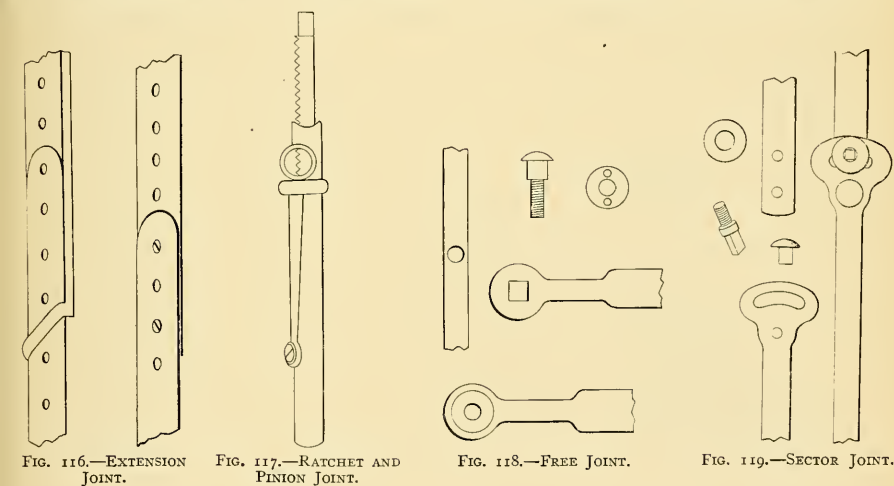
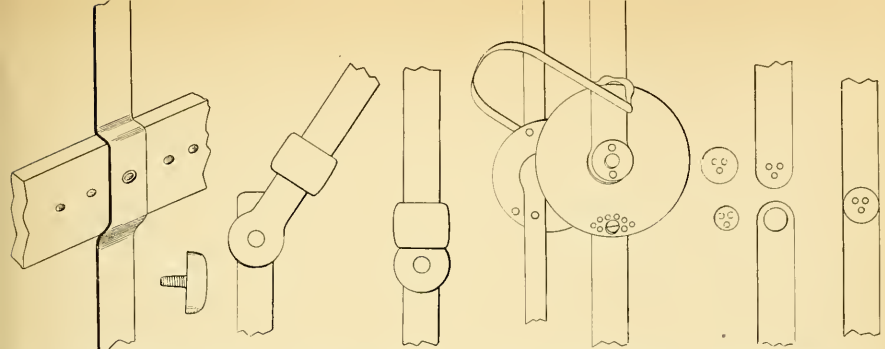


FIG. 123.—STOP JOINT.

If the pressboard is used, this may be cut out and verified by applying it to the deformity.

The proper taking of measurements for braces requires considerable experience, which can be gained only by actual practice. The outlines which are here given are those which are almost universally employed, and can be used with advantage by instrument-makers in constructing apparatus prescribed by the surgeon.

For the fitting of apparatus surgeons require certain orthopedic tools, the most important of which are the bending irons or "crows" and the bending forceps. The other tools, which include screw-driver, stillette, and different forms of keys, are sometimes combined in a portable set. In using the bending irons they should be placed upon the same side of the steel and parallel with

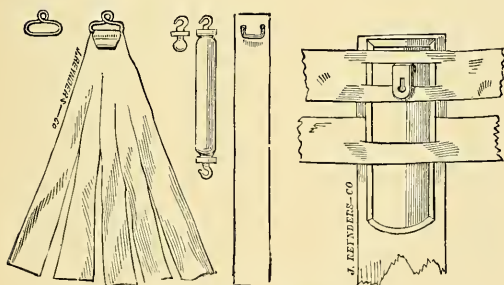


FIG. 124.—RUBBER MUSCLES.

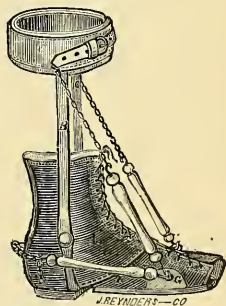


FIG. 125.—CLUB-FOOT SHOE.
A, upper; B, steel upright;
G, steel arch.

each other and the bending should be effected by separating the ends which are not attached to the steel. By using them in this manner and avoiding screw-holes steel may be bent without breaking.

Joints.—The most important parts of orthopedic apparatus are the joints. The simplest combination which constitutes a joint is known as the free joint. This consists of two pieces of metal fastened together with a pin and permitting of motion in two directions like a hinge. In order to prevent friction and wearing of the parts these are usually made more elaborate by forgings and the addition of separate pieces, and in some cases they are made detachable. The detachable joints are most useful at the ankle-joint, since by employing a joint of this kind different pairs of shoes may be used with the same brace. In addition to the free joint we have the lock joints of different kinds. These may be of the simplest form, as the ring or drop catch, or they may be a more

elaborate arrangement known as the Congdon joint, or a still more elaborate one, the trigger joint. When extension is desired, the rack and pinion extension joint is the one most generally in use; and when fixation is desired in different positions, the universal ball-and-socket joint is usually employed, as in the attachment of the head-piece for cervical caries or in the different forms of club-foot shoes. A free joint is sometimes fixed at certain points, when it is known as a stop joint. By means of these stop joints motion is limited, and they find very frequent employment at the ankle, knee, and hip. A variety of fixed joint

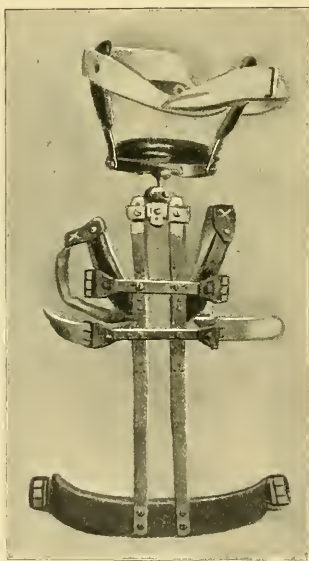


FIG. 126.—TAYLOR SPINE BRACE, SHOWING FINISHED APPARATUS.

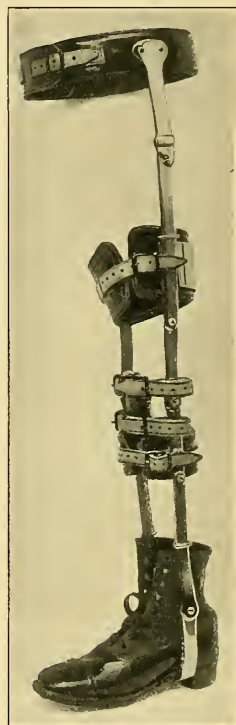


FIG. 127.—PARALYSIS BRACE, SHOWING FINISHED APPARATUS.

which is sometimes found useful is the sector splint. This consists of a semi-circular plate of steel fastened to the upright and permitting of adjustment at certain angles by means of screws or pins. These are very useful about the knee-joint.

Leg braces are usually attached to the shoes by means of stirrups, and

these are made in a great variety of shapes and forms. Springs are used in connection with braces to apply traction or pressure. These may be made of finely tempered steel or of spiral steel, and in some instances rubber muscles are used, especially in paralytic deformities, to assist the weak muscles. In the treatment of club-foot special apparatus is used, and all forms of club-foot shoes are fashioned upon the principle of the Scarpa shoe, in which the power is transmitted by an Archimedean screw. Rubber muscles have also been used in connection with this apparatus, as in the Sayre club-foot shoe.

The finishing of apparatus is largely a matter of personal fancy, since if the principle upon which the apparatus is applied is correct, an elaborate finish is a matter of secondary importance. It is very important in all cases that apparatus should be prescribed by the surgeon, and that patients should not be permitted to select their own braces from catalogues, and much less should instrument-makers sell braces to patients. In every case the apparatus should be made to order for the individual, and neatness, lightness, and strength of construction should be carefully studied by the surgeon, and every effort put forth to assure the production of a completed apparatus which will at once be elegant in appearance and yet as inconspicuous as possible, since the deformed are usually hypersensitive.

Orthopedic Apparatus and Appliances.—In addition to iron and steel, which are most commonly employed, aluminum, brass, bronze, plaster, wood, hard-rubber, celluloid, paper, etc., have been used in the construction of orthopedic appliances. When apparatus is manufactured in regular shops, the finest steel is used, as a rule, but many useful appliances may be made in any part of the country from materials which are at hand. Every practitioner should be prepared to apply plaster-of-Paris dressings. Wood may be used in the preparation of splints or to reinforce the plaster-of-Paris dressings.

In orthopedic practice the use of adhesive plaster is very general, the plaster being spread upon heavy canton flannel. The best of this plaster is the Maws moleskin plaster, made in London, and the Shiver swansdown plaster, made in Philadelphia. When applied for purposes of traction, the plaster is cut into many-tailed bandages and is applied to the limb by overlapping. The dressing is then held in place by a muslin roller, which is either sewed or secured with a strip of adhesive plaster.

Adhesive plaster dressings are very frequently employed to make pressure

upon the joints or to strengthen them after sprains. The Gibney or Cottrell dressing for sprained ankle is an excellent example of the method of applying this variety of dressing.

Couch or Bed Bandages.—The adhesive plaster dressing is used for traction with the patient placed upon a couch or bed, with the limb elevated or abducted, in order to overcome deformity. Different forms of this variety of traction appliances have been devised, among which may be mentioned as especially valuable the Freiburg extension (and the Taylor extension).

Bed bandages are more or less elaborate appliances which are used in correcting deformity while the patient is in the recumbent position. The patient may be suspended by a sling of canvas, leather, or other material, the

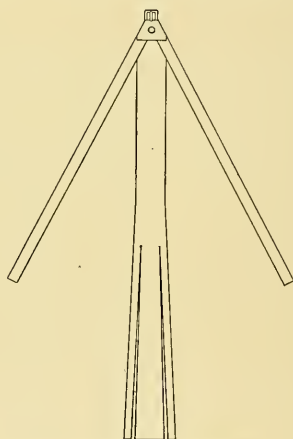


FIG. 128.—TRACTION PLASTER.

body-weight being used as a counter-extending force, as in the Barwell sling. Or the body may be bent backward upon a bent frame, as in the one used by the author, or in the much-used prone couch of Lonsdale. The frame may be so arranged that the patient can be taken into the open air, as in the author's wheel couch. Or the patient may be secured to a wooden frame by means of plaster-of-Paris bandages, and can then be carried about from place to place as in the Phelps plaster-of-Paris portable bed.

Plaster-of-Paris Splints.—The plaster-of-Paris bandage should be made of crinoline, washed or unwashed, or gauze, cut into bandages of different widths varying from 2 inches to 6 inches, and the plaster-of-Paris thoroughly

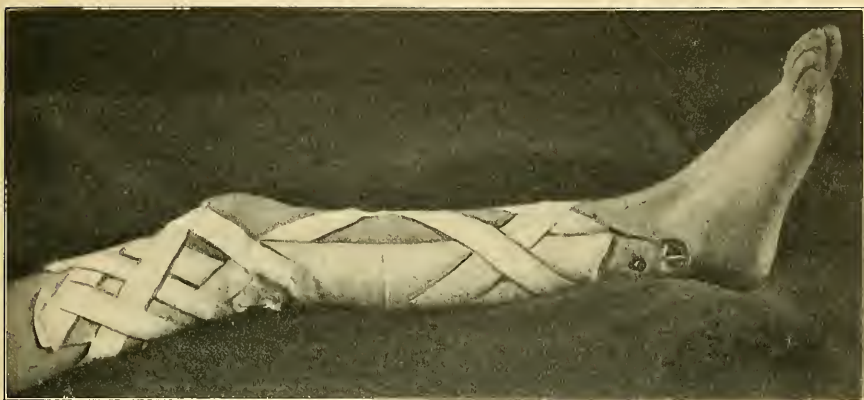


FIG. 129.—AUTHOR'S TRACTION PLASTER APPLIED.



FIG. 130.—AUTHOR'S WEIGHT AND PULLEY BED TRACTION APPLIED.

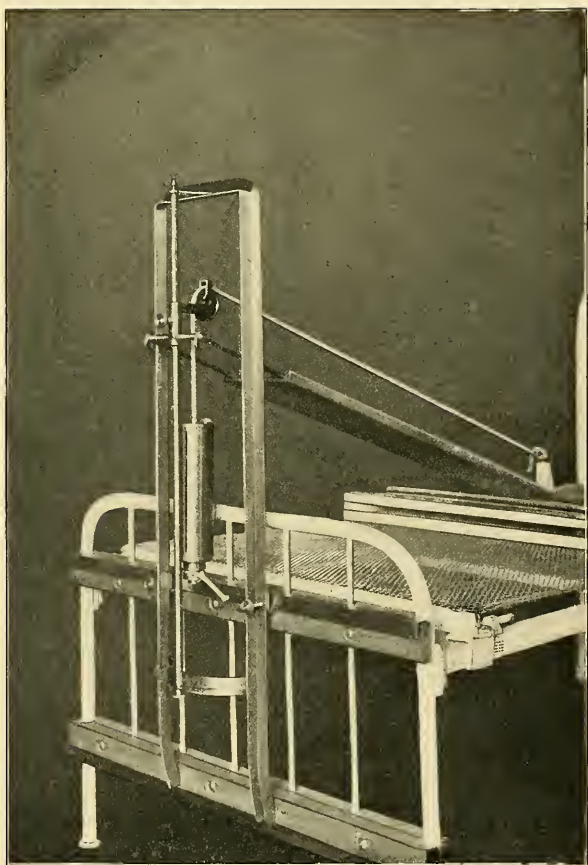


FIG. 131.—FREIBURG EXTENSION.



FIG. 132.—COTTRELL DRESSING.

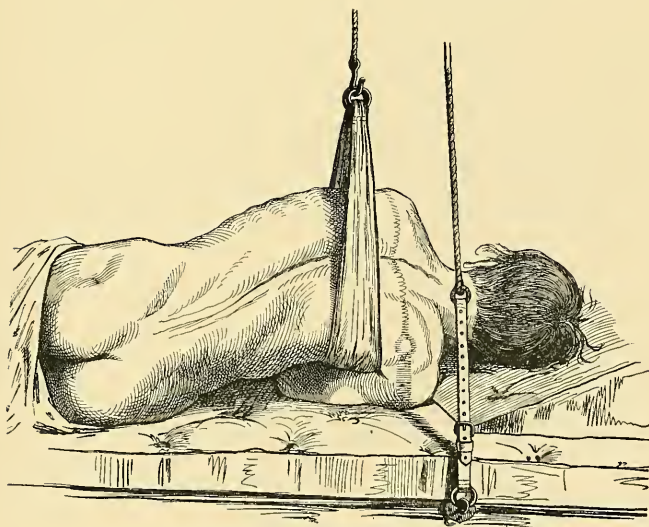


FIG. 133.—BARWELL'S SLING (Hoffa).

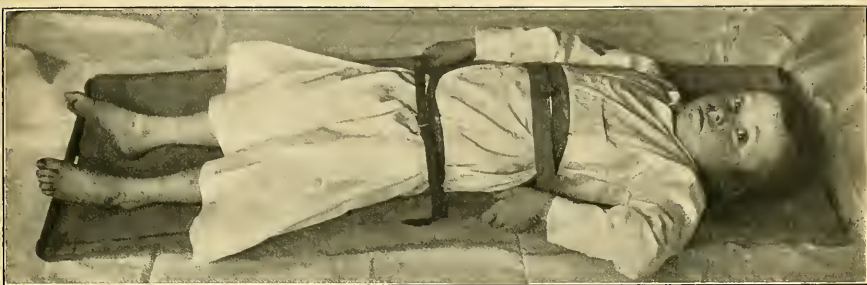


FIG. 134.—AUTHOR'S BENT BED FRAME.

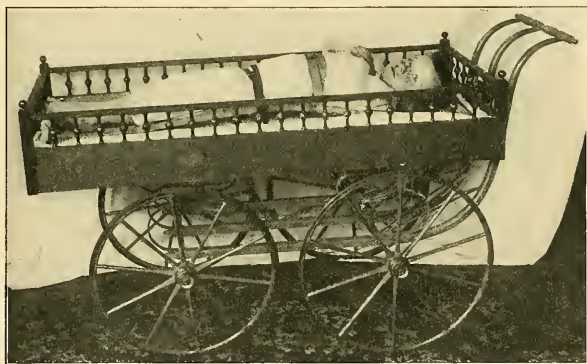


FIG. 135.—AUTHOR'S WHEEL COUCH.

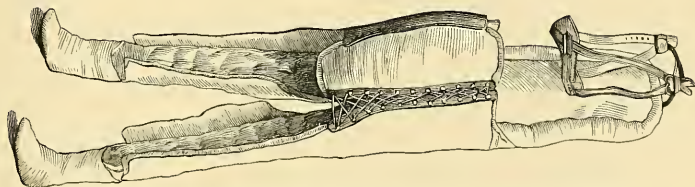


FIG. 136.—PHELPS' PLASTER-OF-PARIS PORTABLE BED FOR HIP-JOINT DISEASE.

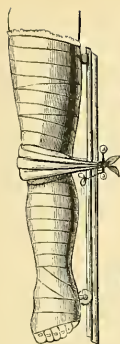


FIG. 137.—HEINE'S PLASTER CAST (Schreiber).

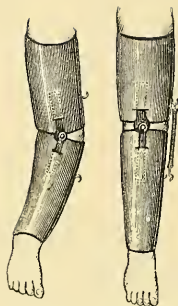


FIG. 138.—MIKULICZ'S PLASTER BANDAGE (Schreiber).



FIG. 139.—VOGT'S PLASTER BANDAGE WITH ELASTIC TRACTION (Schreiber).

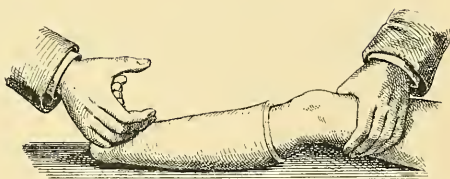


FIG. 140.—ANKLE DRESSING (Hoffa).

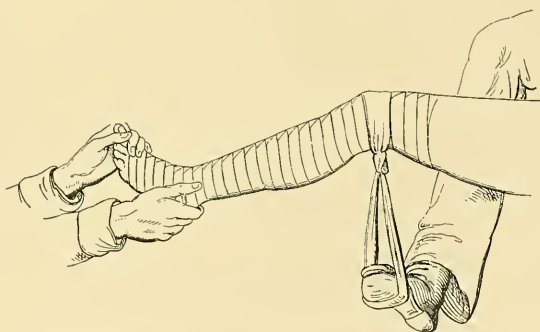


FIG. 141.—KNEE EXTENSION FOR PLASTER BANDAGE (Hoffa).



FIG. 142.—AUTHOR'S FRAME FOR APPLYING SPINE CAST.



FIG. 143.—AUTHOR'S FRAME FOR APPLYING SPINE CAST, SHOWING FRAME READY FOR USE.

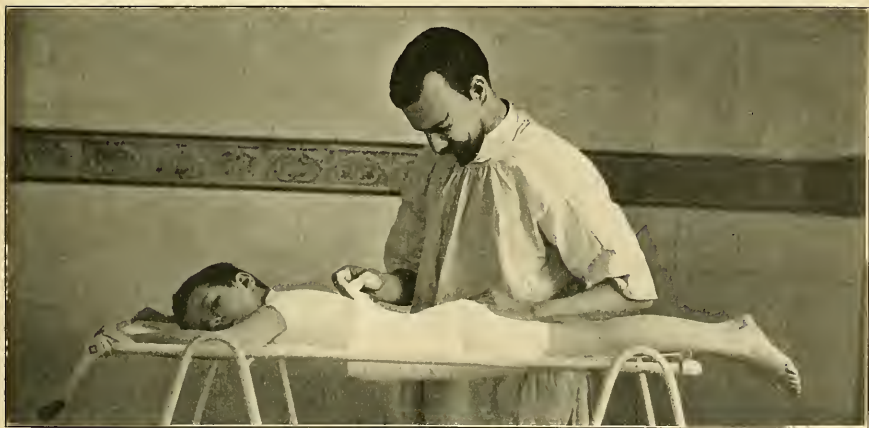


FIG. 144.—AUTHOR'S FRAME FOR APPLYING SPINE CAST, SHOWING PATIENT IN POSITION.

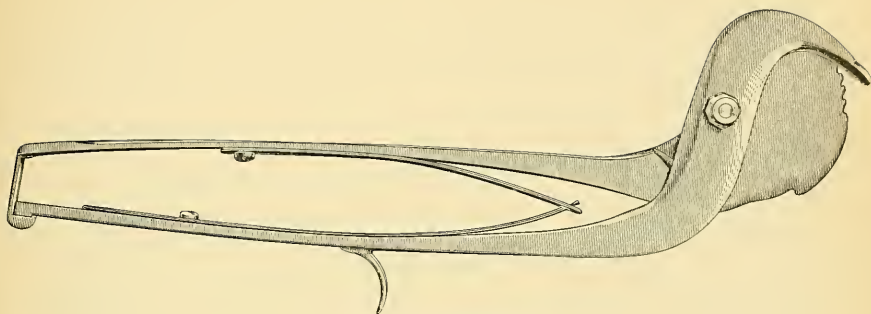


FIG. 145.—REED PLASTER CUTTER.

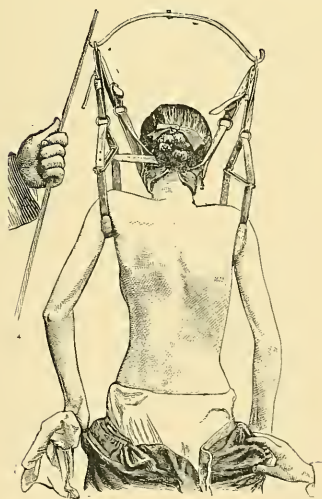


FIG. 146.—PATIENT SUSPENDED READY FOR THE PLASTER (Stimson).

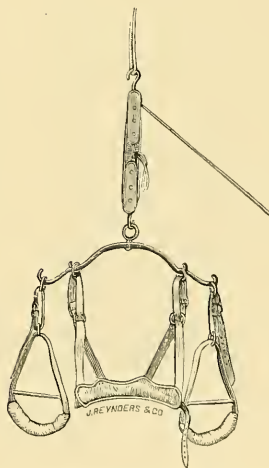


FIG. 147.—SUSPENSORY APPARATUS FOR APPLICATION OF THE PLASTER JACKET.

rubbed into the meshes of the cloth. The bandages should be softened in water containing a little alum and salt. They should be stood on end in sufficient water to cover them and be allowed to remain until bubbles cease to rise, when they should be squeezed moderately dry. In applying the bandages the layers should overlap about two-thirds, they should be applied smoothly without being tight, reverses should not be used, and every layer should be thoroughly rubbed



FIG. 148.—CELLULOID SUPPORT FOR CERVICAL CARIES.

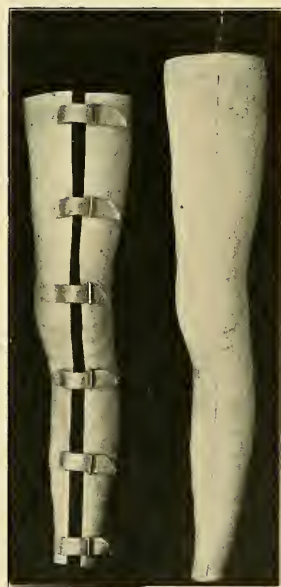


FIG. 149.—CELLULOID SPLINT FOR KNEE-JOINT DISEASE.

into the preceding layer. Four or five layers will be found sufficient to form a very firm bandage for the extremities, and six to eight for the spine. All prominences should be well padded.

Plaster-of-Paris jackets may be applied to the body either by suspension, as in the Sayre suspension apparatus, or, what is more satisfactory, especially

for children, the patient, with the body covered by a closely fitting stockinet undervest, is placed face downward upon a special frame made of gas-pipe to which canvas or unbleached muslin has been securely attached, and the plaster-of-Paris dressing is then applied, the canvas or muslin being incor-



FIG. 150.—FRAME FOR MAKING SPINAL CUITRASS.



FIG. 151.—STOCKINET APPLIED.

porated into the dressing and afterward removed. The manner of applying this cast is well shown in the author's frame for applying spine casts.

Celluloid Splints.—Celluloid is of late being extensively used for the manufacture of splints. A thin strip of celluloid may be softened in hot water

and applied to a plaster-of-Paris mold, or, preferably, small pieces of celluloid or pyralin may be dissolved in commercial acetone to the consistency of a thick



FIG. 152.—PLASTER APPLIED.

syrup, which should be kept in a tightly closed jar. The splint is made by applying five or six layers of stockinet successively over a plaster-of-Paris model, applying after each layer of stockinet four or five coatings of the liquid celluloid. This splint should not be removed from the model for four days, otherwise it is liable not to retain its proper shape. At the end of this time it is split anteriorly and a light coating of celluloid is applied to the inside. The edges are held together by means of leather strips containing eyelets, which are applied to the edges and can be laced together; or else straps with buckles attached may be passed around the splint at intervals of four or five inches and riveted into place.

Felt Splints.—Felt splints are made by soaking the material in a saturated solution of shellac in alcohol and applying over a plaster-of-Paris model. Repeated coatings of the shellac and alcohol are applied until the felt ceases to absorb. After twenty-four hours the splint can be removed from the model and finished. It is usually necessary to reinforce the splint with strips of metal, or, what is preferable, Russian felt which has been saturated with sizing may be fitted to the counter-cast by means of heat.



FIG. 153.—SPINAL CUIRASS.

A felt cuirass for use in cases of spinal deformity may be made, and may include the head, neck, and trunk. The patient is placed face downward upon a specially constructed frame covered with canvas. Stockinet is applied to fit snugly to the parts which are to be included in the cuirass and a plaster-of-Paris cast is applied. From this an exact counter-cast is made, and over

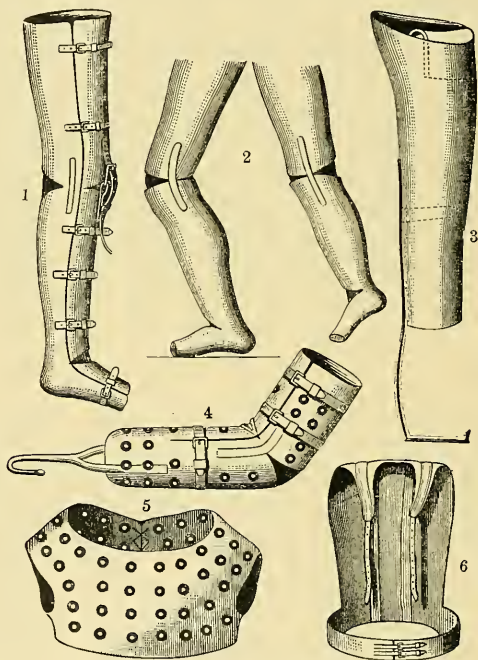


FIG. 154.—SILICATE OF SODA DRESSINGS (Hoffa).

1, Paralysis brace; 2, knee apparatus; 3, hip splint; 4, artificial arm; 5, corset; 6, spine brace.

the counter-cast felt is fitted by means of heat applied with a tailor's goose. The head portion may be made removable from the body portion and the entire cuirass should be reinforced with steel bands. It should be perforated in order to make it lighter and more comfortable in the warm weather. The cuirass is secured to the body by broad webbing into which elastic webbing has been incorporated, and a frontal band and shoulder-straps complete the apparatus.

Silicate of Soda Splints.—Silicate of soda requires considerable time to dry, and is, on this account, little used for the manufacture of splints. It may be painted on with a brush to the bandages as they are applied to the part,

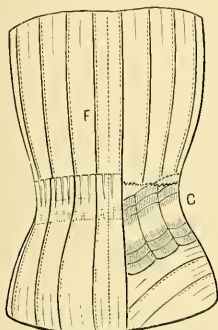


FIG. 155.—WOODEN CORSET, SHOWING LAYERS.
F, Vertical layers; C, reinforced layers.

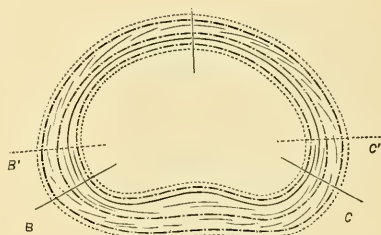


FIG. 156.—SECTION OF WOODEN CORSET.
----- Stockinet; ----- linen batiste;
————— wood; B B', C C', overlapping of front and back layers.

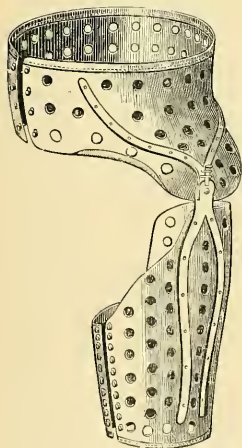


FIG. 157.—WILLARD HIP SPLINT.



FIG. 158.—MARSH KNEE SPLINT.



FIG. 159.—MARSH ANKLE SPLINT.

and covered for a day with a light plaster-of-Paris bandage, or they may be made on a plaster-of-Paris model. The edges of the finished splint may be laced together.

Paper Splints.—Paper is used to some extent for making corsets and

splints for the extremities. These are made by first applying over the counter-cast of plaster a tight-fitting gauze stockinet and applying the paper over this in thin strips fastened together with the best quality of glue. These strips are applied in a manner similar to that used in manufacturing corsets of wood, and the successive layers may be held together with a layer of fine muslin. The manufacture of these splints is difficult and they do not stand the heat

as well as leather jackets, but they are lighter than apparatus made of any other material.

Wood.—The use of wood in the manufacture of corsets has made a valuable addition to orthopedic armamentaria. As made by Waltuch, of Odessa, the wooden corset consists essentially of a wooden cuirass constructed somewhat similarly to the felt and leather jackets, and composed of alternate layers of stockinet, wood, roller bandage, and linen held intimately together with glue. For its manufacture special pine or fir strips, or wood bandages, are employed. Ordinary plaster-of-Paris casts are not adapted to the preparation of wooden bandages, since they are very brittle and are destroyed by the pounding and hammering in the process of veneering, but Braatz models are very firm, being made of a mixture of oakum and liquid plaster. The layers must be applied in a particular order so as to secure strength. This is well shown in the illustration (Fig. 156).

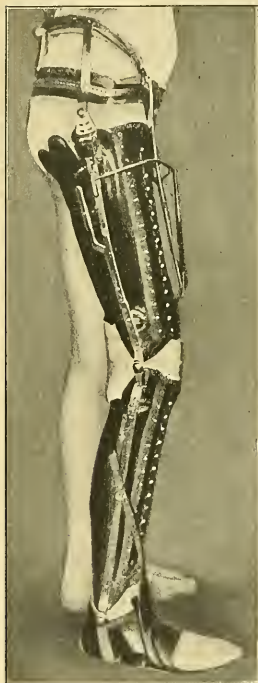


FIG. 160.—HESSING LEATHER APPLI-
ANCE (Joachimsthal).

Wooden corsets when completed do not weigh more than one-third as much as the lightest plaster-of-Paris casts. The firmness

of the wooden corset is rendered very great by reason of the crossing of the fibers of the wooden bandages. It is somewhat affected by the heat of summer, but not so greatly as are felt corsets, nor is it so warm as the felt or leather. Wooden corsets may be made cooler and lighter by perforations. When properly made, this variety of orthopedic appliance is a graceful and elegant apparatus. It is valuable in lumbar Pott's disease,

as a cervical collar in high Pott's disease, or as a retention splint in knee-joint and ankle-joint disease.

Leather.—Leather splints are not so much employed as formerly because of the difficulty in obtaining proper material. The process of manufacture of this form of appliance consists of three parts—the making of the cast, the making of the counter-cast, and the application of the leather.

In making the cast of the part,—for example, that of the body,—the cast is applied with the body in the best corrected position, a tin strip being used in the front, upon which the cast may afterward be cut open. Before the bandages are entirely hard the front of the cast is divided upon the tin strip with a very sharp knife, and it is then removed and allowed to dry. The counter-

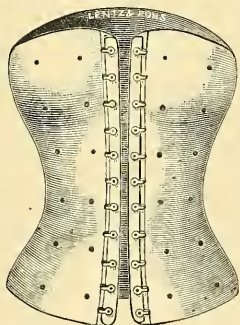


FIG. 161.—PERFORATED LEATHER JACKET.

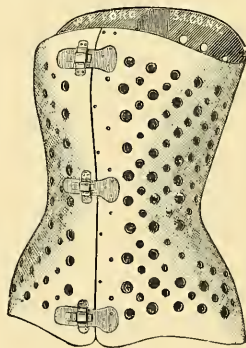


FIG. 162.—PHELPS' ALUMINUM CORSET.

cast is then made by placing the cast upon a board, and sealing it up the front and to the board at its marginal edges, and filling it with liquid plaster. When this has hardened, the original cast is removed, and the counter-cast may be modeled in such a manner as to improve the deformed parts and permit of pressure by the apparatus when completed. When the counter-cast is thoroughly dry, the leather should be applied. Rawhide may be used, but half-tanned skin or leather without oil or dressing will be found most useful. This should be soaked in cold water for twenty-four hours or in warm water for one hour.

Before applying the leather to the counter-cast two tight-fitting shirts should be applied, and the leather then wrapped about it. If the deformity is very great, oblique incisions should be made with a sharp cobbler's knife so that the material may be adapted to the concavities. The wet leather is

fitted to the cast by wrapping about it a tightly wound rope. It is then allowed to become thoroughly dried, and is finally baked in an oven, after which it should be perforated, trimmed, and bound, and it may be finished with shellac or flesh-colored enamel.

If raw cow's hide is used, it must be kept in lime-water, and may be prepared by the use of special chemicals, of which acetate of aluminum is the principal one. This may be made transparent by the use of linseed oil.

Aluminum.—Aluminum has been used in the manufacture of corsets, and when this material is used it is necessary to make it in two parts, front and back, or two lateral parts, which can be fastened together with a hinge. It is beaten into shape in the same manner as repoussé brass work, and may then be fitted over a modeled counter-cast.

Artificial Limbs.

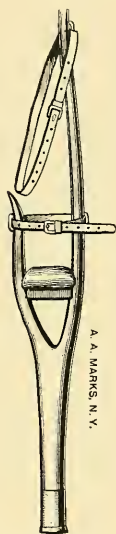
Artificial limbs are employed in orthopedic surgery either for (1) arrested growth or congenital absence of parts, or (2) after amputations which have been performed for disease or deformity.

Surgeons differ as to the proper time when artificial limbs should be applied, since a certain amount of time must be allowed for the natural shrinkage of the part and before the cicatricial tissue will permit of weight-bearing. In most instances a period of three months should be allowed to elapse from the time of the amputation before attempting to fit an artificial limb properly.

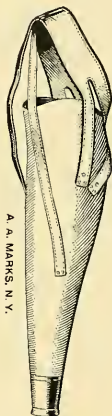
There are at the present time three varieties of artificial limbs in use—the old-fashioned peg leg, a hollow appliance made of willow wood and having an articulating joint at the ankle, and also an apparatus of the same nature with the addition of a rubber foot, and without the articulating ankle-joint. In Philadelphia the artificial limbs invented by Palmer, and later manufactured by Osborn, Kolbe, and others, are appliances characterized by durability, lightness, and elegance of manufacture. The more recent addition of the rubber foot by Marks, of New York, has made the artificial limb nearly perfect. In fact, so closely do they serve the purpose of the natural limb that individuals who are compelled to wear them often feel as if they had their own extremities beneath them. In the case of the little girl illustrated in the chapter upon "Congenital Absence of Parts" the artificial apparatus gave her the sensation as of being her own limbs.

Artificial limbs should be so constructed as to receive the part in such a manner as to distribute the pressure evenly over the entire surface, so that

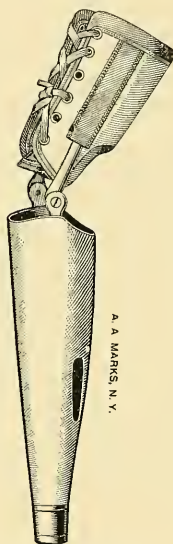
the weight-bearing does not rest altogether upon the extremity. The fit must be very accurate so that there will be no chafing of the stump. If the



A. A. MARKS, N. Y.



A. A. MARKS, N. Y.

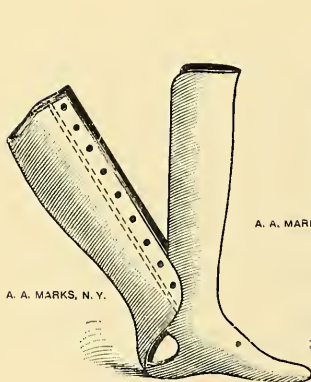


A. A. MARKS, N. Y.

FIG. 163.—ORDINARY PEG LEG.

FIG. 164.—IMPROVED PEG LEG.

FIG. 165.—PEG LEG FOR AMPUTATION BELOW THE KNEE.



A. A. MARKS, N. Y.

A. A. MARKS, N. Y.

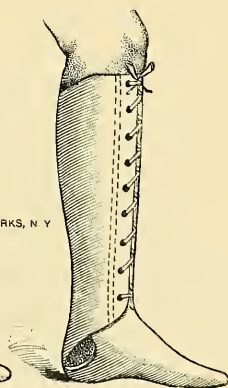


FIG. 166.—ARTIFICIAL LIMB FOR ANKLE-JOINT AMPUTATION.

FIG. 167.—ARTIFICIAL LIMB FOR FOOT AMPUTATION.

fit be accurate, a certain amount of slipping of the stump is desirable. Artificial limbs are sometimes made water-proof so that persons requiring them may

be enabled to pursue occupations where it may be necessary to stand in damp places, or so that they may indulge in trout-fishing, aquatic sports, etc. The

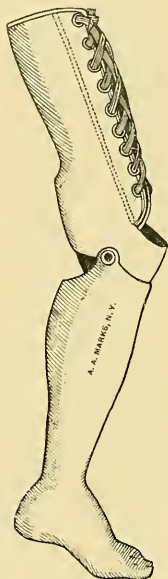


FIG. 168.—ARTIFICIAL LIMB FOR KNEE-JOINT AMPUTATION.

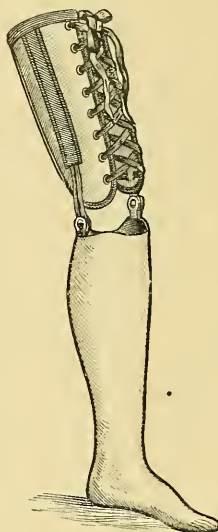


FIG. 169.—ARTIFICIAL LIMB FOR AMPUTATION BELOW THE KNEE.

use of the rubber foot is a decided advantage, since there is no mechanism at the ankle-joint to get out of order and the weight is transmitted to the ground with greater precision and security.

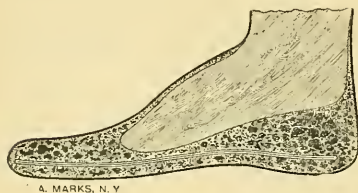


FIG. 170.—RUBBER FOOT.

In the choice of amputation the orthopedic surgeon has a decided advantage over the general surgeon, since in most conditions requiring amputation in the field of orthopedics the parts are not devitalized by traumatism. In amputations of the thigh it is best to

leave the stump as long as possible in order to increase the leverage, whereas in amputations of the leg it has been found that amputations in the middle or upper third of the leg are better adapted to the use



FIG. 171.—MANIPULATION FOR ANKYLOSIS OF SHOULDER.



FIG. 172.—MANIPULATION FOR ANKYLOSIS OF ELBOW.



FIG. 173.—MANIPULATION FOR ANKYLOSIS OF KNEE—FLEXION.



FIG. 174.—MANIPULATION FOR ANKYLOSIS OF KNEE—EXTENSION.

of artificial apparatus. In amputations of the foot so much difficulty has been experienced in fitting artificial apparatus that there has been a tendency among surgeons to perform amputations through the leg. This should be avoided, since many of the deformed conditions following partial amputations of the foot can be readily fitted with orthopedic shoes or with some appliance.

The use of orthopedic apparatus for deformities resulting from arrest of growth or congenital absence of parts partakes of the nature of artificial limbs, and in many instances a properly fitting artificial limb will answer every purpose. If the deformed limb is only slightly shorter than its fellow, the deficiency may be made up by a properly constructed shoe, or by the addition of cork, aluminum, etc., to the shoe. If the deformed member extends only as far as the knee, the part can be encased in an artificial limb, the foot resting over the joint of the artificial appliance. If the lower extremity is entirely wanting, an artificial limb, the same as used in cases of amputation, may be applied at the hip-joint. In this instance it will be necessary to have at the knee a locking and unlocking joint in order to afford stability in walking. When both lower extremities are wanting, an apparatus such as is shown in the chapter upon "Congenital Absence of Parts" will be found of use.

Orthopedic Operations.

Operations performed by the orthopedic surgeon may be comprised under the two heads of bloodless or forcible correction, and those performed with the knife.

Forcible Correction.—This method of correcting deformity is extensively used in orthopedic surgery for making correction in such affections as club-foot, torticollis, dislocation of the hip, bow-legs, and ankylosed joints. The force may be applied by means of the hands, when it is spoken of as manual correction; or it may be accomplished by the aid of machines, when it is spoken of as mechanical correction. The complete correction is sometimes accomplished by force or it is sometimes applied after cutting operations have been performed.

Corrective manipulations are especially valuable in cases of ankylosed joints. A soft thick pad should be applied in such a manner as to allow the joint to be free. The operator holds the joint so as to protect the epiphysis from injury, and by gradual flexions and extensions breaks up the adhesions and restores the function of the part. Manipulations of this kind are exten-

sively employed in ankylosis of the shoulder, elbow, knee, and ankle. Where greater force is required than can be accomplished with the hand, special machines are used, as the Goldthwaite machine for ankylosis of the knee or the

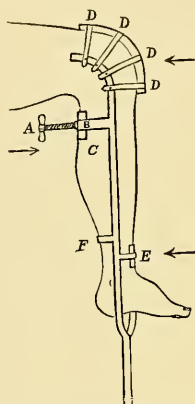


FIG. 175.—GOLDTHWAITE MACHINE FOR CORRECTION OF ANKYLOSIS OF KNEE APPLIED.

A, Screw; B, steel band; C, pressure plate; D, E, counter-pressure straps; F, leg strap.

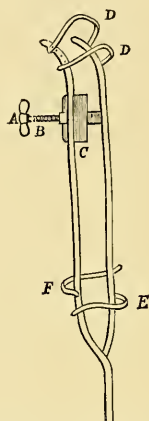


FIG. 176.—GOLDTHWAITE MACHINE FOR CORRECTION OF ANKYLOSIS OF KNEE.

Thomas, McKenzie, and Gibney club-foot wrenches. When properly applied an enormous amount of force may be exerted without injury to the part, the Phelps machine for the correction of club-foot being capable of applying pressure to the amount of 2000 pounds.

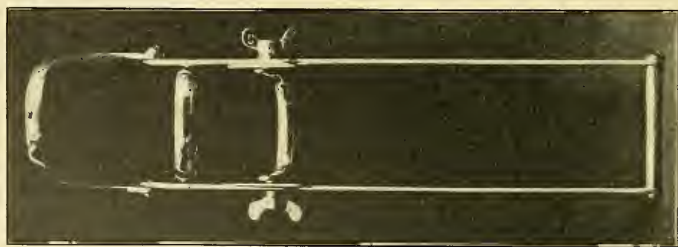


FIG. 177.—MCKENZIE CLUB-FOOT WRENCH.

Osteoclasis, or forcible fracture of bones by means of instruments, has been much employed of late, both abroad and in this country, for rachitic and other deformities of the lower extremities. This method of correction is more appli-

cable to the shaft of the bone, as in bow-legs, in which locality it is slightly safer than osteotomy. The objections to this method are the lack of precision and the liability of the splintering of the fragments, the rupture of the



FIG. 178.—THOMAS CLUB-FOOT WRENCH.

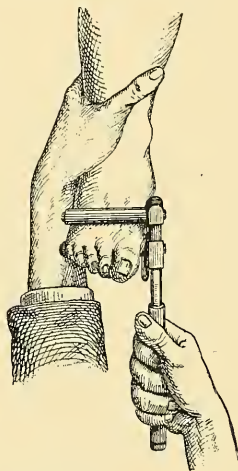


FIG. 179.—SAME APPLIED.

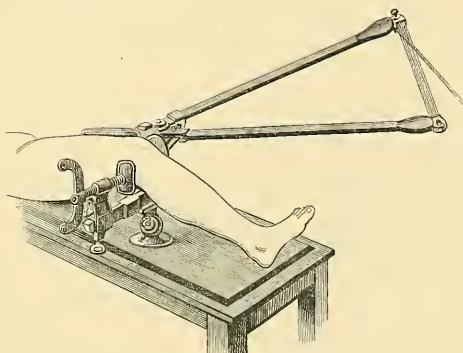


FIG. 180.—COLLINS OSTEOCLAST.

ligaments, and the separation of the epiphysis; but these objections are more theoretic than real, and when properly applied and skilfully used it is a very valuable method of correction.

Excellent osteoclasts have been invented by Collin, Lorenz, Robin, Grat-

tan, and the one which the writer has employed for some years, that invented by Rizzoli. The term "rapid osteoclasy" has been applied to the method as performed by Blanchard with the Grattan osteoclast. He reports 262 cases of rachitic deformities corrected by rapid osteoclasy and osteokamptosis without

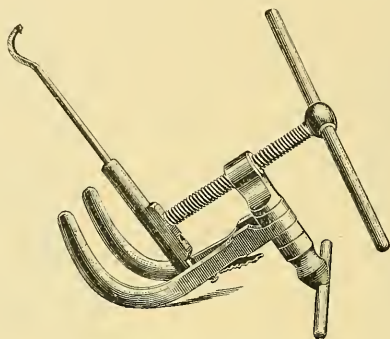


FIG. 181.—GRATTAN OSTEOCLAST.

a single injury, abrasion of the soft parts, or epiphyseal separation. The ages varied from four to sixteen years, the average being seven years and nine months. The compression time in the osteoclast did not exceed eight seconds, and the entire time for the details of the operation seldom exceeded six minutes.

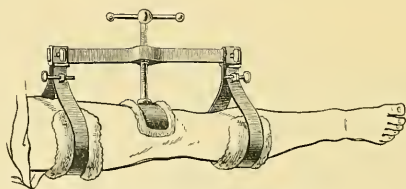


FIG. 182.—RIZZOLI OSTEOCLAST.

The operation of osteoclasy should not be performed before four years of age, and the best time is the sixth year.

The technic with the Grattan osteoclast is as follows: In breaking the tibia in the middle of its shaft the limb is firmly fixed by the hands of an assistant in such a position that the central portion, or plunger, will strike upon the most prominent portion of the deformity, the lower and upper resistant bars

being placed at such a distance from each other as to allow the fracture to occur and not to encroach upon the epiphysis at either extremity of the tibia. In using this instrument for knock-knee the lower resistant bar is placed over the external condyle and the upper resistant bar is separated about four inches. The limb is securely held by the hands of an assistant and the breaking bar is rapidly screwed down so as to break or bend the bone at the point selected.

In using the Rizzoli osteoclast for correcting bow-leg in the tibia the limb should be rendered thoroughly aseptic, as for a cutting operation, and should be bound securely in gauze compresses and a towel. The limb is placed through rings which are separated as widely as possible without resting upon the epiphysis, and the plunger is applied over the inner surface so as to strike the point of greatest convexity. After the fracture has been accomplished the limb is dressed in gauze, a flannel or gauze roller is applied to the limb, and while it is held in a slightly overcorrected position a plaster-of-Paris dressing is applied. Before this has entirely hardened it should be divided upon a tin strip with a sharp knife, or if it has hardened it may be divided with a plaster cutter.

The Lorenz osteoclast is employed to correct deformity in the neighborhood of the joint. The ligaments are stretched, the shaft of the bone is bent, and in some instances actual separation and displacement of the epiphysis occurs. The operation is always performed under anesthesia, and afterward the limb is secured in an overcorrected position in plaster-of-Paris dressings.

CHAPTER VI.

TENOTOMY.

Two principal methods of tenotomy are in general use, the subcutaneous and the open operation. The former method is still employed in certain localities, as in lengthening the tendo Achillis, and the latter method is employed wherever it is considered safer to expose the tendon and avoid injury to the adjacent structures.

The term tenotomy embraces tenorrhaphy, or the lengthening or shortening of tendons, tendon transplantation, sometimes spoken of as musculo-tendinous anastomosis, and tenoplasty.

A tendon may be lengthened by transverse section, the separation of the parts being accomplished by the muscle tonicity or by the stretching of the part.

According to Wilson, tendon splicing was first suggested by Rhoads, of Philadelphia, was first performed by Anderson, and was first described by Keen.

The dividing or splitting of a tendon may be done by making either a longitudinal or an oblique section. When the longitudinal section is used, the upper and lower portions of the tendon must be divided by a sagittal or cross-cut, from the longitudinal incision outward or from the inside out to the longitudinal cut, thus making a Z-shaped section.

Since this method was first performed by Anderson, it is known as the Anderson method.

This operation, as first performed for "contractions of the fingers and toes," was as follows: A large curved incision is made through the skin and superficial fascias over the tendons to be lengthened. The tendons are lifted up individually upon a grooved director, split longitudinally, and the ends are cut out on either side and are slid past each other, great care being taken to keep the cut surfaces in contact. They are then stitched together with fine chromicized catgut, the fascias and skin are brought together with catgut, and the part is put in a deformed position until healing has occurred.

A modification of this method, described as a subcutaneous operation,

is credited to Bayer. As first described by him, the operation was performed through an open wound, and while the tendon was not lifted out, it would not now be considered a subcutaneous operation. His subsequent operation may be described as follows: Two points are marked upon the skin which indicate the termination of the length of the incision, a small tenotome is introduced subcutaneously into the middle of the tendon and it is divided longitudinally from behind forward or from before backward. The ends are divided and the cut surfaces are slid past each other.

A modification of the Anderson open method has been devised by Rugh, of Philadelphia. It consists in inserting a small splitting knife through an incision one-half to three-fourths of an inch in length. The tendon is then divided for a distance of from two to three inches, the knife is withdrawn in the same line and pushed in the opposite direction the same distance, splitting the tendon for from four to six inches. The upper and lower ends of the tendon incision are marked upon the skin with a sharp-pointed tenotome, and after the

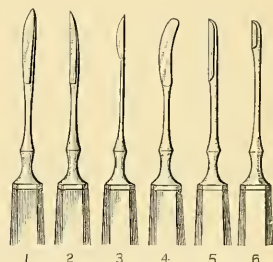


FIG. 183.—AUTHOR'S TENOTOMES.

1, Straight, blunt-pointed; 2, straight, sharp-pointed; 3, convex, sharp-pointed; 4, convex, probe-pointed; 5, straight, probe-pointed, long cutting face; 6, straight, probe-pointed, short cutting face.



FIG. 184.—TENOTOMY AFTER BAYER (Joachimsthal).

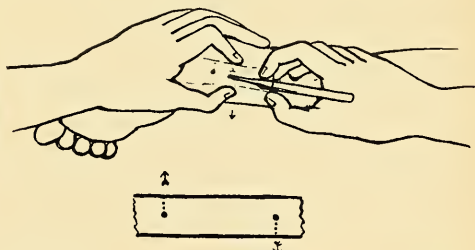


FIG. 185.—BAYER'S SUBCUTANEOUS TENOTOMY (Joachimsthal).

withdrawal of the splitting knife the tenotome is introduced on one side of the tendon and on the other side at the other end, and the tendon is slowly divided down to the longitudinal slit. The ends are slid past each other the desired length and are sewed together through the skin incision and the incision is closed with catgut sutures.

The advantages claimed for this operation are the short skin incision, and the lessened danger of sepsis and of sloughing. There is one objection to this and the Bayer method; that is, where the tendon is twisted. When this condition is encountered, the tendon cannot be divided subcutaneously, and the Anderson operation has to be performed.

The tendon may also be divided higher than the usual section, cutting through the tendon into the muscular portion, so that as the deformity is corrected the tendon remains in partial contact with the cut muscle, or a number of small notches may be made at different points along the side of the tendon.

Immediately following a well-performed operation of lengthening a tendon a process of regeneration begins by the effusion of a fluid or semi-fluid lymph exudate from the peri-tendineum internum and externum. A very little blood is effused into the space from which the upper part of the tendon has been retracted. If much blood has been effused, it retards the formation of the proper exudate. The adjacent blood-vessels enlarge and the tissues about the wound become infiltrated, yellow, and succulent. This exudate takes no part in the reparative process, and usually ceases in twenty-four hours. Somewhat later—three to seven days—the proper reparative material makes its appearance (the inflammatory exudate ceases or degenerates) and fills the entire space between the divided extremities of the tendon and unsheaths them both for a short distance. The stumps of the cut tendons swell, and microscopically many mitoses may be seen both in the central and peripheral areas. Fine young tendon fibers are gradually differentiated into bundles of connective tissue. This gradually becomes firmer, stronger, and grayer, and forms a distinct bond of union between the ends of the tendon. The differentiation gradually advances, at first rapidly, later more slowly, in time becoming identical, even microscopically, with the original tendon.

Adams in his dissected cases showed that the tendon and sheath at the point of section had almost entirely returned to its normal condition, and could scarcely be detected on the closest scrutiny; and Sir James Paget says, in referring to the specimens of tendo Achillis, posterior and anterior tibial tendons, deposited by Tamplin in the Museum of the Royal College of Surgeons, which had been divided four months before death, that “no trace of division of any of the tendons could be detected even with microscopic aid.”

There is, however, in all instances a difference in the separability of the sheath of the divided tendon over the seat of the previous operation, if the dissection be carried from above downward or from below upward.

Of late years the method of immediate restoration, and, in fact, of slight over-correction, after tenotomy is the one usually adopted by all practical surgeons. Under these circumstances it is very interesting to observe that this reparative exudate is always sufficient to fill the space between the severed ends, which in some instances is very great. In a case related to me by Prof. Willard the ends were separated three inches and firm union occurred. The most interesting feature of the process, however, and the one bearing directly upon the subject of over-correction, is that brought out by some investigations of the writer upon rabbits, which demonstrated conclusively that if the ends of a divided tendon be separated a very short distance, but a small amount of exudate fills the space; if they be separated a great distance, the entire space is filled in; and if they be separated at first but a short distance, or the ends remain in contact, and are subsequently separated, the resulting tendon will be a weakened, spindle-shaped one, from the stretching-out of the plastic exudate.

Technic.—In performing subcutaneous tenotomy much of the success depends on the technic. If the pointed tenotomes be employed, as, for example, the slightly sickle-shaped knife of Dieffenbach, no other instrument is needed; but if blunt, rounded tenotomes are used, another sharp-pointed bistoury must be employed for the puncture of the skin, and this is always a disadvantage, but one that cannot be overcome in certain localities. Tenotomes are best made in sets of six or eight, the cutting surface of the largest of which should not exceed an inch in length and one-fourth of an inch in breadth. They should be made of one piece of metal, nickel-plated, strong in the shank to avoid the danger of breaking off in the wound; and a set of this kind should include one or two pointed knives with rounded bellies for cutting small superficial tendons, and one pointed, flat-bellied tenotome with long cutting-face for cutting the plantar fascia. Anesthesia is not absolutely essential, owing to the short time required for the operation, but is usually employed to overcome movements on the part of the patient which might interfere with the operation.

The day before the operation the skin should be rendered aseptic by a careful cleansing with green soap and water, a thorough washing with 1:1000 bichlorid solution, and a wet compress should be applied for twelve hours. Immediately before the operation it should be again prepared by washing the part with green soap and sterile water, either with a skin-brush or with gauze sponges. It should then be washed with alcohol, to be followed by a solution of 1:1000 bichlorid of mercury. It should then be dried with

gauze sponges and the surface washed with ether. All callus should be removed from the feet before the operation, as this would make painful pressure beneath the dressing. In some instances where the skin is very thick, or discolored, or foul, it should be prepared for several days previous to the operation by applying first a saturated solution of permanganate of potash for three minutes, followed by a saturated solution of oxalic acid for the same length of time, after which the preparation before described may be used. The aseptic preparation of the part should be very carefully carried out, particularly where the open operation is performed.

The surgeon's hands should be very carefully prepared by washing thoroughly with soap and water, using a hand-brush; the nails should be carefully cleaned and the hands dipped in alcohol. They should then be held for three minutes in a saturated solution of permanganate of potash and for three minutes in a saturated solution of oxalic acid, and then be thoroughly washed in a solution of 1:1000 bichlorid of mercury, and finally washed in sterile water, in which the rubber gloves should be put on.

The skin having been previously rendered aseptic as described above, the parts are so held as to render the shortened tendons prominent. The skin over the tendon is then punctured about its middle in such a manner that this incision and the one in the deeper parts shall not correspond when the parts are relaxed. The tenotome is carried flatwise beneath and close to the under surface of the tendon, the cutting-edge is turned against it and the division accomplished by a slight rocking motion. The section is usually evidenced by an audible crackling and the extension of the contracted part. The assistant should at once relax the part. The tenotome is then turned flat and withdrawn, the operator compressing the wound to prevent any ingress of air. The puncture is dusted with acetanilid or thymol iodid, dressed with a small wet bichlorid compress, and by a superficial dressing of gauze and cotton, and a prepared or flannel roller. The parts should then be placed in a slightly over-corrected position and retained in position by a metal retention-shoe which allows inspection, or a plaster dressing. The wound need not be inspected for ten days unless pain or elevation of temperature calls attention to the part.

Complications of Tenotomy.—Owing to the prominence of the contracted tendons there is not the same difficulty there would be in the normal state, and not the same danger of wounding adjacent structures, hence the complications following tenotomy are therefore few and usually slight. There may be:

1. Too great wound in the tissues or puncture of the opposite side from movements of the patient. With an antiseptic dressing such accidents are of no importance.

2. Profuse hemorrhage from wounding a large artery, as the anterior or posterior tibial or plantar fascia, is sometimes alarming, but calls for an antiseptic compress, a ligature being seldom necessary. Such an accident can usually be avoided by inserting the tenotome in such a manner as to avoid the artery, and then cutting away from it. For this reason, in section of the tendo Achillis, if a sharp-pointed tenotome be employed the puncture should be made on the inner side to avoid the risk of wounding the posterior tibial artery with its point.

3. A traumatic aneurysm may be treated with a firm compress or the vessel may be ligated.

4. The section of a nerve, which, although a disagreeable complication, calls for no special concern, as the ends, if sutured, will probably unite in a short time.

5. Incomplete section of a tendon, which should be guarded against by observing that the tendon is completely severed before the tenotome is withdrawn. Otherwise the operator must forcibly rupture the undivided fibers or reinsert the knife.

6. Suppuration, which very rarely occurs, but should be met by free drainage and antiseptic dressings.

7. The non-union of a divided tendon is an exceedingly rare occurrence, but one which may happen. Adams reports having witnessed it once, and this where the tendon had been divided in a situation not usually selected by orthopedic surgeons. The possibility of such an occurrence should be avoided by selecting in all cases the proper locality for section.

While experience confirms the truth of the statement that the accidents of tenotomy are few and usually slight, these operations are not, however, entirely free from dangerous complications. Thus, Agnew records the fact that he has seen death from erysipelas follow the division of the adductor longus tendon at its origin; has known a child to perish from concealed hemorrhage after an operation for club-foot, and has seen a leg rendered useless in a great measure from section of the peroneal nerve during tenotomy of the outer hamstring.

The individual tendons most frequently requiring division by the subcutaneous method are the tendo Achillis, the tibialis anticus, the plantar

fascia, the peroneal tendons, and the inner hamstring; and those by the open method are the sternocleidomastoid, the outer hamstring, and the tibialis posticus.

Division of the Tendo Achillis.—In dividing this tendon the patient, etherized, is placed upon the breast or side; an assistant renders the tendon moderately tense by flexing the foot. The puncture is then made with the sharp-pointed tenotome, about one inch above its insertion, a short distance from the tendon to be divided, and preferably to the outer or fibular side, to avoid injury of the posterior tibial artery. The blunt-pointed tenotome is then



FIG. 186.—MAKING PUNCTURE FOR TENOTOMY OF TENDO ACHILLIS.

inserted into the puncture flatwise, and carried behind the tendon as close as possible to its posterior surface; the edge is then turned against the tendon, and by a slightly rocking, not a swinging, motion the tendon is divided, care being taken not to divide the skin nor to enlarge the puncture wound. The division of the tendon is evidenced by a sensible and audible snap, the sinking-in of the soft parts and the extension of the heel. The assistant should at once relax the parts immediately the section is accomplished. The knife is then turned flat and withdrawn, pressure being made with the finger to prevent the ingress of air. The parts are then dressed as before given.

The writer has twice met with quite a severe hemorrhage in dividing the tendo Achillis, once in an infantile case and once in a young adult who had been previously operated upon. It appeared to come from a small unnamed artery which supplies the sheath of the tendon, and was in each case readily controlled by a firm compress. An attempt should always be made to control even the slightest amount of bleeding from tenotomy, lest the blood-clot in the sheath interfere with the normal healing process.

Division of the Tibialis Anticus Tendon.—This tendon is divided



FIG. 187.—DIVIDING THE TENDO ACHILLIS.

about two inches above its insertion, the points for its division being found from the prominence of the tendon on the inner aspect of the foot a short distance above the scaphoid tubercle. In many cases the puncture used for dividing this tendon will also answer for the division of the plantar fascia. For the division of this tendon a sharp-pointed tenotome alone will suffice. The knife is inserted beneath the tendon, its edge turned upward, and division easily accomplished, care being taken to avoid wounding the skin.

Division of the Plantar Fascia.—This fascia is divided at its most prominent point. A sharp tenotome alone may be employed, or if the division is to

be extensive a blunt tenotome will be preferable. The puncture used for the section of the anterior tibial tendon may be employed, or a new puncture may be made in the inner side of the sole of the foot nearly midway between the os calcis and the ball of the great toe, but a little nearer the os calcis. The knife is carried close to the fascia flatwise between it and the skin, the blade is turned toward the sole of the foot, and the section accomplished. In infantile cases it is advisable to make but small sections at one time, repeating these if necessary. Should the internal plantar artery be completely divided, it will not complicate the operation; but if it be wounded in division of the plantar fascia, a few days should elapse before instituting restitution and extension, lest aneurysm result.

Division of the Peroneal Tendons.—If the slightly sickle-shaped knife be employed, no other instrument is needed; but if a probe-pointed tenotome be used, another sharp-pointed instrument must be employed to puncture the skin. Anesthesia is not absolutely necessary, and in dividing this tendon the writer usually employs local freezing with ice and salt. The parts, rendered aseptic and insensible, are held in a position which renders the affected tendons prominent. A puncture having been made a short distance behind the external malleolus, so that it will not correspond with the one in the deeper tissues when the parts are relaxed, the blunt-pointed tenotome is passed either over the tendons, between them and the skin, and the division of the constricted tendons accomplished by cutting directly down upon the external malleolus, or, as the writer prefers, the tenotome is passed beneath the tendons and the cut is made directly outward, care being taken not to cut the skin nor increase the size of the puncture. The proper division of the tendons is evidenced by an audible crackling and the fact that the foot now remains in its normal position. The tenotome is then turned flatwise and withdrawn; the operator, compressing the wound to prevent the ingress of air, places an antiseptic dressing upon the part, and secures it in position with a plaster-of-Paris bandage. Over-correction is not necessary in these cases, as relapse is not so likely to occur as after the section of contracted tendons.

Division of the Inner Hamstring Tendons.—The division of these tendons in adults may ordinarily be accomplished by subcutaneous tenotomy. The tendons should be located with the finger about an inch from their insertion and the puncture should be made with a sharp tenotome and the division made with a blunt-pointed tenotome inserted from within outward. If the deformity is very great, it is always safer to make an open section;

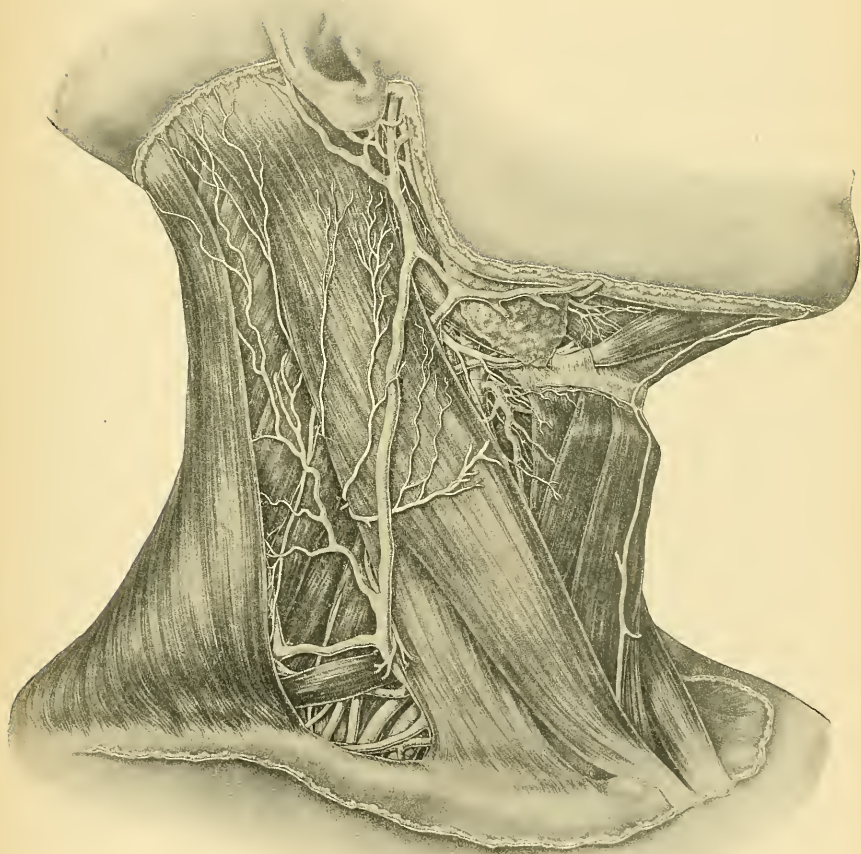


FIG. 188.—SUPERFICIAL STRUCTURES OF THE NECK (Deaver).
Showing relations of sternomastoid muscle.

and if there is any doubt about the exact position of the tendons on account of their displacement, it is much safer to expose them and make the division.

Tenotomy of the sternomastoid may be performed subcutaneously or by open incision. The operation of subcutaneous tenotomy is one of great delicacy, and not entirely free from risk, three fatal cases having been mentioned by Mr. Erichsen. Both the sternal and clavicular origin may require division. Anesthesia is necessary, and the dorsal position is preferable, with the head well extended and rotated to the sound side. The sternal portion is best divided about half an inch above its origin, from within outward. Care being taken to avoid the anterior jugular vein, if present, a blunt-pointed tenotome should be introduced flatwise in front of the upper margin of the sternum anterior to the inner edge of the muscle, and be passed outward beneath the deep surface, the edge turned forward, and, with a slight sawing motion, the tendon be divided. The clavicular portion may be divided through the same puncture, but is better and more safely accomplished by a second puncture between the two portions, the cautious insertion of the probe-pointed tenotome behind the tendon, and its division from behind forward. After the division the tenotome must be withdrawn flatwise, and the punctures be immediately sealed. The disadvantages of subcutaneous tenotomy are the difficulty of dividing the deep bands and the danger of wounding important vessels.

Open Incision: In aggravated cases the deeper cicatricial bands may be preferably divided by the open incision. Under full aseptic precautions, a vertical incision along the inner border of the muscle, or preferably an

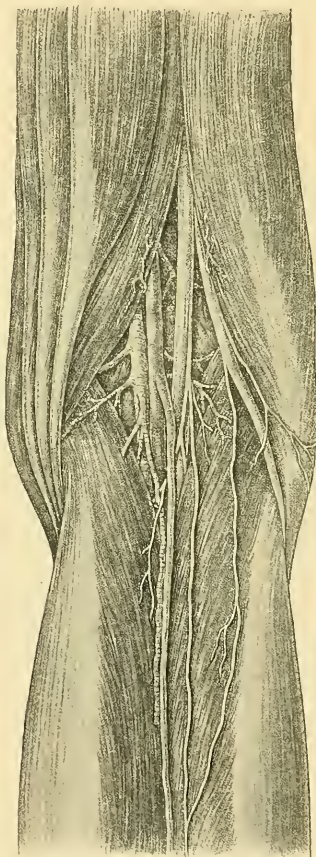


FIG. 189.—POPLITEAL SPACE (Deaver).
Showing relations of hamstring tendons.

incision parallel with and one inch above the clavicle, should be made. With forceps and the handle of the scalpel, the platysma, the muscle sheath, and cicatricial bands may be separated and divided cautiously upon the grooved director. The deeper cicatricial bands should be firmly secured between two strong forceps before being divided. Great care must be exercised to avoid wounding the internal jugular vein, by relaxing the neck and not opening the deep cervical fascia.

The wound should be sutured with catgut, and the head be secured in



FIG. 190.—OPEN OPERATION FOR TENOTOMY OF BICEPS TENDON.

an over-corrected position, by plaster or silicate of soda dressing, or other mechanical means, for from ten to fourteen days, when the after-treatment should be begun.

Division of the Outer Hamstring Tendon (Biceps).—The contracted biceps tendon can usually be located beneath the skin. It is best divided by an incision four inches in length carried along its inner margin. The incision may be made in such a manner as to expose both the inner side of the biceps tendon and the outer side of the peroneal nerve. A grooved director

should be inserted beneath the tendon from within outward so as to avoid the nerve. If there is any doubt about the position of the peroneal nerve in the incision, it is best to expose it, if possible, so that it will not be divided. The wound should be closed with catgut sutures and dressed as in the subcutaneous operation.

Division of the Tibialis Posticus Tendon.—The subcutaneous division of this tendon requires both practical knowledge of anatomy and precision in the use of the knife. In adults the tendon is so prominent that at



FIG. 191.—OPEN OPERATION FOR TENOTOMY OF TIBIALIS POSTICUS TENDON.

times it may safely be divided in this manner. The puncture is best made about two centimeters above the tip of the internal malleolus in a line drawn vertically midway between the posterior border of the malleolus and the corresponding border of the tendo Achillis. The tendon itself must always be divided by means of a blunt tenotome for fear of wounding the posterior tibial artery. It must be recollected that at this point the posterior tibial artery is located between the tendons of the flexor longus digitorum and flexor longus pollicis, to the inner side of the former being the tendon of the tibialis posticus, and to the outer side of the latter the posterior tibial vein and the post-

terior tibial nerve, the artery being, therefore, the middle of these five structures. The internal saphena vein and nerve are superficial and anterior to the puncture. The blunt-pointed tenotome should be carried perpendicularly downward to the depth of one or one-and-a-half centimeters, the handle made to describe the arc of a circle, so as to turn the cutting surface of the blade forward and against the tendon, and the latter be divided vertically inward. Its division will be evidenced by a slight snap and a slight change in the position of the foot. The danger of wounding the posterior tibial artery is probably exaggerated, Adams having met it but once in a very large experience, and Bonnet having wounded it more than once, but only a few times and without subsequent serious injury. In Mr. Adams's case, and in a similar one recorded by Mr. Tamplin, the injury resulted in a false aneurysm, but both patients subsequently recovered. The injury to this vessel is evidenced by a florid jet of blood and the blanching of the foot. In such an event a firm compress should be accurately applied and maintained in position by a roller for some days. This may be sufficient, as in a case recorded by Agnew. In the majority of cases puncture will be followed by aneurysm, which will require ligation of both ends of the sac, as in the cases recorded by Tamplin, Bradford and Lovett, and others.

The rule laid down for the section of this tendon is the one to be employed in subcutaneous division, and in some adult cases the tendon can be located with great ease and precision, and may then be divided by simply locating it with the finger and cutting forward against the bone.

On account of the difficulty of dividing this tendon safely it is better to divide it by the open method, selecting a point about an inch above the usual locality for the division by the subcutaneous method. A vertical incision is made close to the border of the tibia, beginning at a point one inch above the tip of the malleolus. The incision is carried upward an inch and a half, the fascia over the tendon is opened, the tendon is raised upon a grooved director or dry dissector, and divided. The wound is closed by one or two catgut sutures.

After-treatment of Tenotomy.—The after-treatment requires as much if not more attention to detail than the operation itself, and on this depends much of the success. Indeed, many authorities believe treatment to have commenced only when the foot has been straightened by forcible means and tenotomy.

At the expiration of ten days the foot should be inspected, and if in good

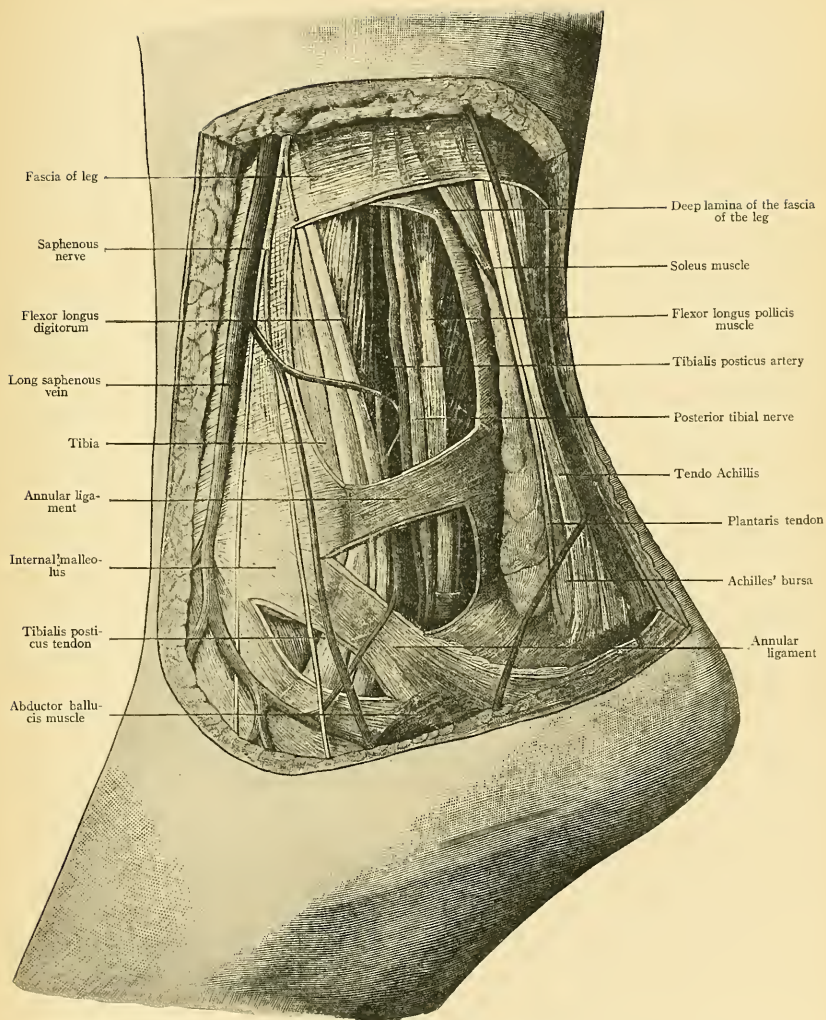


FIG. 192.—REGION BEHIND THE INNER ANKLE, NATURAL SIZE (after Von Bardeleben and Haeckel).
Showing relations of posterior tibial tendon.

condition it should be placed in a well-constructed mechanical walking-shoe. At least once a day, and preferably twice a day, the foot and leg should be rubbed with linimentum saponis, bathing whisky, or extract of witch-hazel, and manipulated, particularly over the muscles and tendons which were formerly contracted. This is very important and tends to free and strengthen the tendons. The skin over bony joints subjected to pressure should be hardened by the application of a solution of alum in alcohol. At night for some months the foot should be placed in a retention night-shoe, by which any tendency to relapse may be corrected.

Electricity should not be omitted. It should be applied to the whole part to improve the nutrition of the skin and deeper structures, but it should be more particularly applied to the contracted or paralyzed muscles.

Tendon Shortening.—Tendons may be shortened by an oblique division and an overlapping of their ends, or they may be folded upon themselves, or they may be ruffled.

In shortening a tendon by the first method, as the tendo Achillis, the tendon must be exposed by a longitudinal incision and lifted on a grooved director and divided in the direction of its fibers by a central incision which is cut out at each end, the ends being secured with forceps. The cut surfaces are then slid past each other and the deformed part is placed in such a manner that the overlapping may be accomplished. Very fine sutures are inserted to hold the cut surfaces in position, the sheath is held together with a second row of sutures, and the skin is held together with a third row of sutures. The part is held in the corrected position until a plaster-of-Paris cast is applied.

Reeves has described a method of shortening the tendo Achillis which is as follows: "An incision is made down to the tendon, the sheath is opened, and the tendon raised by a blunt hook or spatula, and folded or pinched between the fingers until the size of the piece required is ascertained. A silver suture is then passed through the tendon about a quarter of an inch above and below the points of the proposed section, to prevent a slipping away of the tendon within its sheath. The segment is removed, the extremities approximated, the ends of the wire twisted and buried in the tendon. In this manner one-half to two-thirds of an inch may be removed."

Walsham and Willett perform an operation which consists in dividing the tendon obliquely, and sliding the cut ends past each other until the desired shortening is attained, and stitching them very closely together with chromicized catgut or kangaroo tendon, including the skin and tendon. Or a flap

including one-half of the tendon may be detached and stitched to another portion of the tendon which has been freshened. The tendon may be ruffled by threading a needle with a double thread and passing it longitudinally through the tendon several times and drawing on the thread more or less tightly before it is tied.

Transplantation of Tendons.—There are three methods of transplanting tendons. The first consists in dividing the tendon of a sound muscle and inserting it into a slit in the paralyzed muscle; the distal extremity of the divided tendon is again attached in the same manner in an upward direction into a tendon of another sound muscle. In this manner the tendon of the extensor longus pollicis may be attached to the tibialis anticus and the distal extremity be attached to the extensor communis digitorum. The second method consists in taking a slip from a sound tendon and inserting it into a slit in a paralyzed tendon. In this fashion a slip from the extensor longus pollicis may be attached into the tibialis anticus. The third method consists in dividing a sound tendon and attaching it near the insertion of the paralyzed tendon. The distal extremity is then attached to another sound tendon. For example, the sound tendon of the extensor longus pollicis may be attached to the periosteum over the scaphoid bone, the distal extremity of the cut tendon then being attached to the extensor longus digitorum.

The greatest care must be observed in the technic of this operation to have it thoroughly aseptic. Silk boiled in a 1:1000 sublimate solution is considered by many to be the best material, but chromicized catgut may be used in some situations. A certain amount of tension on the muscles is necessary, but too much tension injures the muscles and too little tension interferes with the action of the tendon. One of the simplest and best methods of transplanting tendons is to carry the sound tendon into a slit which has been made in the paralyzed tendon, securing it in place with interrupted sutures. Where tendons are carried for some distance for purposes of transplantation, tunnels must be made for them with a blunt instrument beneath the subcutaneous tissue. Tendons may be transplanted and attached at a new point in the periosteum, the operation consisting in suturing the tendon to the periosteum and not to a paralyzed tendon. The advantage claimed for this operation is that the operator has a free selection of the point of insertion for the transplanted tendon. Where the tendon is too short to reach the periosteal insertion, it may be attached by silk strands, which afterward become inclosed in a deposit of fibrous tissue, layer upon layer, an intertwining of the fibers, so that it becomes after a time a tendinous band in the center of which is the silk thread.

It has been demonstrated microscopically that the regeneration of tendons after transplantation is the same as that which occurs after subcutaneous tenot-

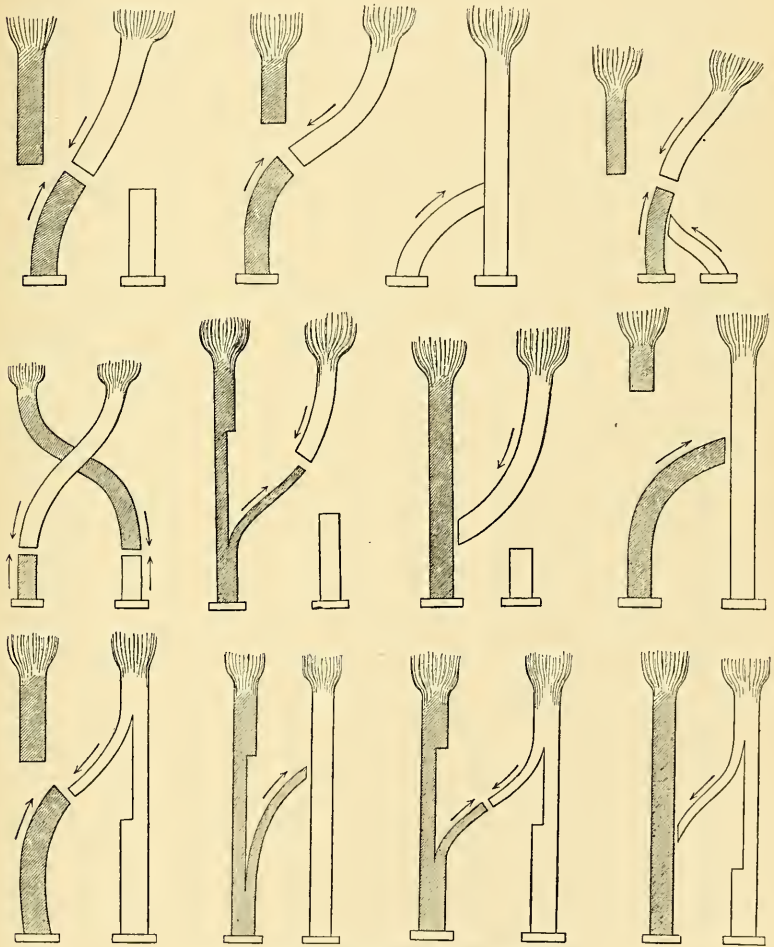


FIG. 193.—TRANSPLANTATION OF TENDON (Binnie).

omy. The tendon-sheath is not regenerated, the healed tendon is grayish-white in color from the cicatrices, and there are additional tendinous bands formed from irritation and extension of the inflammation. The transplanted

tendon heals into position perfectly without much reaction in the transplanted tendon itself.

Aponeurotomy.—This operation consists in the division of the fascias when they are contracted, and may be performed by the subcutaneous or the pericutaneous method. The latter method does not differ greatly from the division of tendons by the open method, the fascia being raised upon a grooved director or dry dissector and freely divided. Aponeurotomy is employed in the division of the palmar fascia for contraction of the hand, the division of the plantar fascia for talipes varus, the division of the fascia about the knee-joint in contraction of the knee, or in the division of the fascia lata in contraction of the hip and knee.

Myotomy.—This operation consists in the division of the muscle for extensive contractions and is indicated where division of the tendons is not sufficient. The operation is usually performed by the open method, or in some situations, as about the hip-joint, the muscles may be divided subcutaneously. Extirpation of the tensor vaginæ femoris for internal rotation has been successfully performed by Gibney.

The transplantation of muscles after their separation from their origins or insertions may be considered under this head. The transplantation of the pronator radii teres from the inner to the outer condyle has been introduced to the profession by Hoffa, and the transplantation of the sartorius muscle into the biceps femoris has been advocated by Goldthwaite.

Neurotomy.—The simple division of a nerve, or neurotomy, is not employed at the present time on account of the union which usually occurs, and which defeats the purpose of the operation.

Neurectomy.—It is now the custom to remove a portion of the nerve when the operation is performed for the purpose of overcoming spasm, and this form of operation is known as neurectomy. Division of the spinal accessory is performed for intermittent torticollis, and neurectomy of the musculocutaneous has been proposed for erythromelalgia.

Neurectomy of the Spinal Accessory.—The nerve may be conveniently exposed by an incision three inches in length along the posterior border of the sternomastoid muscle, the center of which is half an inch above the center of the muscle, or on a level with the upper border of the thyroid cartilage. After dividing the skin, superficial and deep fascias, the head may be flexed and the neck relaxed on the side being operated upon, the muscle may be separated with a grooved director and the finger, and turned forward, disclosing the nerve

where it enters the muscle, or the bottom of the wound may be irritated with a director, the contraction of the muscle serving as a guide to the location of the nerve.

Neurorrhaphy, or Nerve Suturing (Neuroplasty; Nerve Anastomosis; Transplantation of Nerves).—In cases of paralysis produced by the loss of nerves or through the paralysis of the nerves operations are undertaken for the purpose of restoring function. Primary suture has been undertaken for the union of the cut ends of a divided nerve, and nerve-grafting operations are undertaken in order to restore function to incised or paralyzed nerves.

Nerve-grafting may be accomplished by taking a slip from a sound nerve and transplanting it into a paralyzed nerve, known as central transplantation; or, the paralyzed nerve may be divided and the distal extremity may be inserted into a slit in a sound nerve, known as peripheral transplantation of the total central type; or, a slip of a paralyzed nerve may be taken off and inserted into a slit in a sound nerve, known as peripheral transplantation by the partial central method.

The technic of this operation requires the same aseptic precautions as for the open method of tenotomy, and its success depends upon the use of small instruments, eye instruments being preferable, and as little manipulation of the nerves as possible. The divided nerve should be secured in the slit of the sound nerve by means of two or three very fine chromicized catgut sutures attached to the sheath, and the transplanted nerve is so placed that the central canal is in contact with the central portion of the sound nerve and looking in the same direction. The proximal extremity of the paralyzed nerve should be inserted into a neighboring muscle in order to prevent the formation of neuroma. The wound should be closed without drainage and aseptic dressing be applied, and the part be secured for from four to six weeks in a plaster-of-Paris dressing.

In acute anterior poliomyelitis where only one or two muscles remain paralyzed good results may be expected from the anastomosis of the nerve-supply of the paralyzed muscles with a motor nerve in the vicinity. The operation should be performed preferably at about six months, and is not permissible within three or four months after the acute attack. The operation is most suited to those cases in which a few muscles or only a single muscle may be paralyzed. Operations of this character are too few at the present time to give any definite conclusions, but sufficient success has been met to encourage

the hope that satisfactory results will be attained in a large number of selected cases. The report of a successful operation of this kind, performed by the writer, will be found in the "Journal of the American Medical Association," January 21, 1905. In this instance the anterior tibial muscle alone was paralyzed. An incision 10 cm. in length was made, including the skin and superficial fascia over the head of the tibia, downward in the bony axis of the leg. The division of the tibia and fascia exposed the peroneal nerve, and this was found to divide into (1) a fasciculus of nerves supplying the anterior tibial nerve, (2) the anterior tibial nerve, and (3) the musculocutaneous nerve. The branches supplying the anterior tibial muscle were divided as high up as possible and inserted through a perforation in the musculocutaneous nerve, when they were secured on the outer side of the latter with fine catgut sutures. Decided improvement followed the operation, and the control of the muscle subsequently became almost normal.

A later operation, not yet reported, was performed for paralysis of the peroneal nerve, the external popliteal being anastomosed with the internal popliteal. In this case the sensation was restored within twenty-four hours and some improvement in the motor power has been noted.

An operation for quadriceps paralysis has been proposed by Spitzzy. The long branch of the obturator nerve is attached to the cruralis. Another form of nerve transplantation for the relief of paralysis in anterior poliomyelitis has been performed by Peckham. In this the healthy nerve-fibers were cut and united with the degenerated nerve-fibers. This was followed by the rapid restoration of partial function.

A complete bibliography on this subject will be found in the "Zeitschrift f. orth. Chir.," Bd. xiii, Hft. 2.

CHAPTER VII.

OSTEOTOMY.

Osteotomy for the relief of badly united fracture has been performed since the time of Hippocrates. Although Rhea Barton, of Philadelphia, performed osteotomy for hip ankylosis as early as 1826, and Malgaigne suggested subcutaneous osteotomy in 1847, it was not until 1851 that Meyer, of Würzburg, first performed osteotomy for genu valgum. Operations upon other articulations became more numerous, and were performed in this country by Pancoast, Sayre, and Brainard.

The operation of osteotomy consists in a subcutaneous division of part of a bone with a chisel or saw, and fracture of the undivided portion.

The osteotome, or bone-chisel, is a bone-knife and should be employed as such. Different widths should be used, the temper should be midway between the temper of a wood and cold chisel, the point should gradually taper so as to avoid a shoulder, and the side should be marked in half or quarter inches to show how deeply the cutting-edge has penetrated. The instrument should be firmly grasped with the left hand with the thumb against the head to steady it. An ordinary carpenter's mallet answers every purpose as well as the more expensive instruments.

Technic.—A longitudinal incision is made in the skin at the selected point, the osteotome is introduced down to the bone, turned at right angles to the shaft, and driven into and nearly through the bone, by a few blows of the mallet. The osteotome is partially withdrawn, its direction changed, and another section made until the interior of the bone is divided. The instrument is then withdrawn, and the bone is broken by manual force; a catgut suture is inserted, an aseptic dressing is applied, and the part is fixed in an over-corrected or corrected position as desired. Such a section is known as a linear osteotomy.

Several modifications of linear osteotomy have been performed. The combination of osteotomy and osteoclasia has been recommended by Hopkins,

an interval being allowed to elapse after the former for the healing of the wound, the object of the combination being the greater accuracy of the fracture over simple osteoclasia. There is no advantage in submitting a patient to two operations when one will suffice. It has also been proposed to make the division in the bone in rachitic deformities with a Gigli saw. In order to accomplish this, more exposure of the parts is required than for simple linear osteotomy, and only where a resection of a cuneiform piece of bone is necessary is this operation justifiable.

Another form of osteotomy which is of value, particularly about the hip-joint, is performed by means of an electric drill. Parallel holes may be drilled at short intervals in the direction of the desired section, after which the bone may be broken

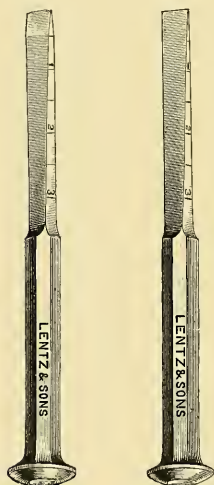


FIG. 194.—MACEWEN'S OSTEOTOMES.

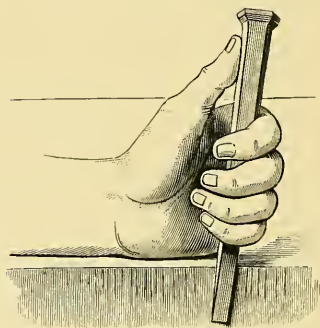


FIG. 195.—POSITION OF HAND IN HOLDING OSTEOTOME.

with the hand. For this method the best drill is the electric drill of Cryer, the speed and direction of which can be perfectly controlled by the surgeon.

Vertical, Longitudinal, or Oblique Osteotomy.—A valuable improvement of linear osteotomy in certain localities is oblique, vertical, or longitudinal section of the bone. This requires more exposure of the tissue, involves more danger of infection, but offers the advantage of lengthening the bones during the correction. It is most valuable in deformity of the tibia and for ankylosis of the hip-joint.

Technic.—An incision 4 to 6 inches long is made at the selected point, exposing the bone; retractors are passed about the entire circumference of

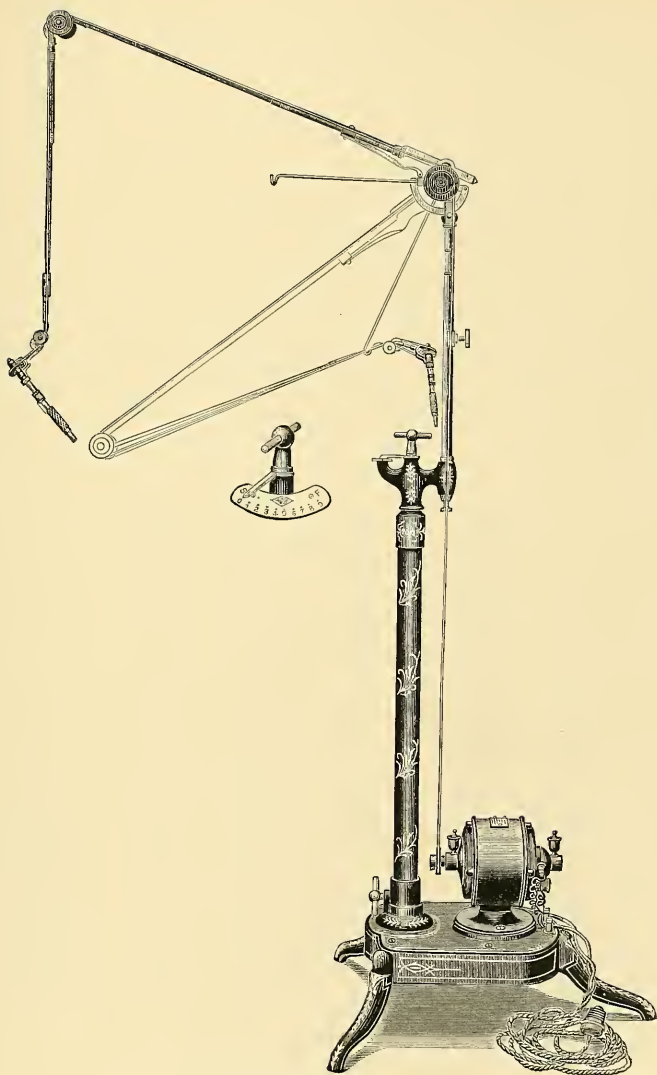


FIG. 196.—CRYER'S ELECTRIC DRILL.

the bone, and the oblique section is made with a broad osteotome. The divided bones are slid past each other, and secured with steel nails, silver wire, or simply fixed in a corrected position in a plaster-of-Paris cast. The length of the bone may in this manner sometimes be increased more than an inch.

Cuneiform Osteotomy.—The removal of a wedge-shaped portion of bone is rarely demanded in the correction of rachitic deformities, since it has been discovered that the overriding of the fragments can be prevented by tenotomy of the contracted tendons. In severe deformity, and occasionally after vicious union from fracture, this operation is desirable. It is best accomplished by first performing a linear osteotomy through a larger incision, and then, by protecting the soft parts with retractors, the desired section may

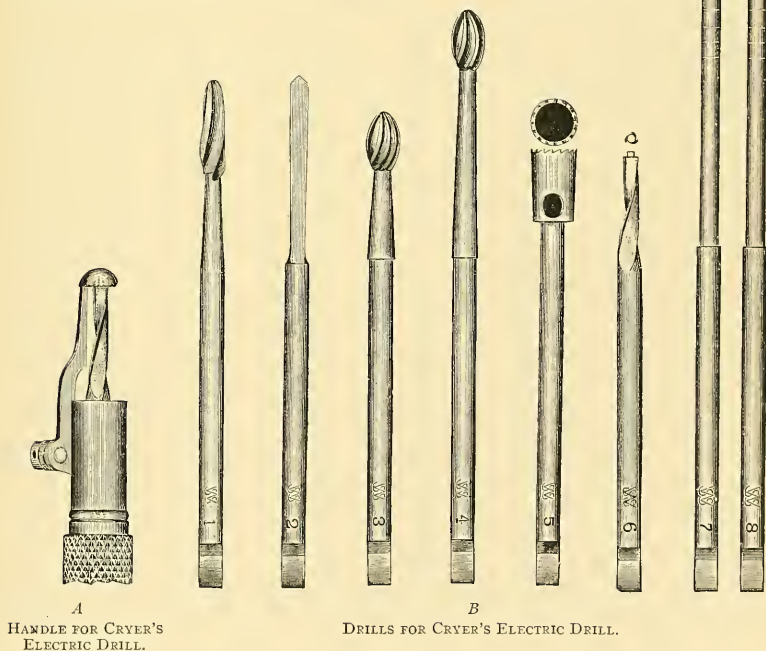
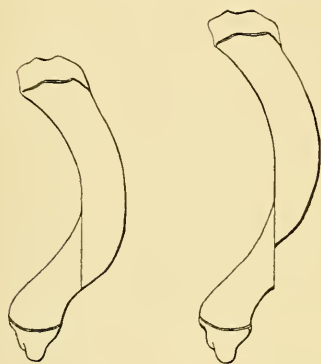


FIG. 197.

be separated; or the end of one fragment may be pushed out of the wound and the section be removed.

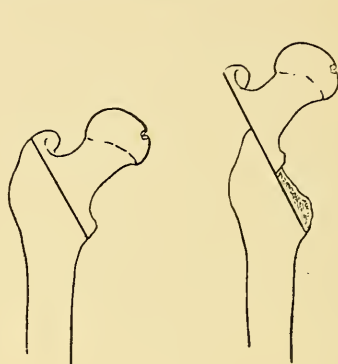
Chondrectomy and Chondrotomy.—In deformities due to the unequal growth of the bones from injury or disease of the epiphysis the partial or com-



A
OBLIQUE OSTEOTOMY
OF TIBIA (Joachimsthal).

B
SAME, LOWER FRAG-
MENT SLID DOWN-
WARD (Joachimsthal).

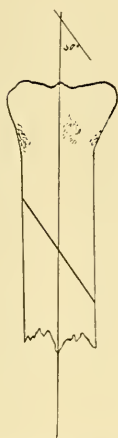
FIG. 198.



a
OBLIQUE OSTEOTOMY
FOR HIP-JOINT (Joa-
chimsthal).

b
SAME WITH
FRAGMENT
DOWNWARD
PUSHED (Joa-
chimsthal).

FIG. 199.



OBLIQUE OSTEOTOMY OF SHAFT
OF TIBIA (Joachimsthal).



SAME, LATERAL VIEW.
(Joachimsthal).



SAME, LOWER FRAGMENT RO-
TATED UPON UPPER (Joa-
chimsthal).

FIG. 200.

plete resection of the epiphysis of the adjacent bone is sometimes followed by good results. Thus in deformity of the wrist from disease of the lower

epiphysis of the radius the removal of the epiphysis of the lower end of the ulna will be indicated to arrest the growth and correct the deformity.

Arthrodesis.—The production of an artificial ankylosis by the removal of a part or all of the cartilage of a joint has been performed for the flail joints due to paralysis. The operation consists in opening the joint by a suitable incision, and removing with a knife or thin chisel a thin layer of cartilage from opposed surfaces of the articulating bones, nailing or sewing the parts together,



FIG. 201.—VOLKMANN'S DOUBLE CURET.

or fixing them in the best position for use by a plaster cast, which is worn until ankylosis is firm. In conjunction with tendoplasty this operation furnished a valuable means of securing a useful member. Thus, for example, in talipes calcaneus from paralysis of the anterior group of muscles, the articulating cartilaginous surfaces of the mediotarsal joint should be removed. The Esmarch bandage may with advantage be employed.



FIG. 202.—BARKER-WILLARD IRRIGATING CURET.

Erasions.—In children and youths the removal of the diseased portion only, or *eration*, as it has been technically named, is preferable to the more formal excisions formerly advocated. These offer the advantage of not interfering with the growth, and admit of repeated operations in case of failure to arrest the disease at the primary operation. The extent of the disease should determine the selection of *eration* in preference to *excision*, and the *x-ray* will



FIG. 203.—ALLIS'S PERIOSTEOTOME.

often materially assist the surgeon in arriving at a proper decision. The incision is usually made over the seat of the disease or through sinuses in such a manner that it can be extended in the lines of a formal excision should this become necessary. All the diseased area is removed with thumb gouge, chisel, knife, or rongeur, the surrounding parts are cureted, cauterized with pure carbolic acid, neutralized with alcohol, and drained with tubes and packed

with sterile or iodoform gauze and allowed to heal by granulation, the part being securely held by a plaster cast.

Articular Resections.—In adults and in adolescents where the disease is extensive, formal articular resections are to be recommended. Resections are also performed for ankylosis, and under these conditions attempts are sometimes made to remove angular sections of the articulating surfaces in order to correct deformity, and Sayre has rounded off the upper end of the femur and deepened a cavity in the lower end of the upper fragment so as to establish an artificial joint. If the fragments can be kept far enough apart, this might succeed; but it usually fails, as in the case reported by the author. A modification of this is seen in the open operation for congenital dislocation of the hip. The new cavity may be made without difficulty with a Doyen borer. In resection of the hip-joint excellent motion is not unusual, especially if the acetabulum has not been extensively involved.

Amputations.—In orthopedic practice amputations are performed for extensive joint disease, for malignant disease, and for incurable deformities, such as in club-foot due to congenital absence of parts.

In children amputations are very rarely required, but in adults they are often necessary early in the disease. The indications for amputation are prolonged suppuration, extensive disease of the shaft, and albuminuria. The special indications for amputations will be considered in the appropriate chapters.

PART II.

SPECIAL ORTHOPEDIC SURGERY.

CHAPTER I.

POTT'S DISEASE OF THE SPINE.

Pott's disease of the spine is a progressive tuberculous lesion of the vertebral bodies or intervertebral discs, leading to their partial or complete destruction, usually terminating in ankylosis with the characteristic posterior deformity.

History.—It is so called from the accurate description of the disease given by Sir Percival Pott in 1779. He described it as a “palsy of the lower limbs, which is frequently found to accompany a curvature of the spine, and is supposed to be caused by it,” and ascribed it to a localization of unhealthy exudates. Its tuberculous nature was first pointed out by Delpech, Nélaton, and the earlier French investigators. The disease was recognized by the ancients, was well known to Hippocrates, Galen, and the earlier writers on medicine, five hundred years before Christ, and had also been previously described by Camper and Severin.

Synonyms.—*English*, Caries, or Osteitis of the Spine; Vertebral Arthritis; Vertebral Tuberculosis; Angular Curvature; Posterior Curvature. *Greek*, Kyphosis. *French*, Mal de Pott; Cyphose. *German*, Spitzbuckel; Winkel-formige; Kinkung der Wirbelsaule. *Italian*, Ciphosi; Morbo di Pott. *Spanish*, Mal de Pott. Most of these are too precise pathologically considered, or obviously contradictory,—as the term “angular curvature,” which from a geometric point of view would correspond to a round triangle, or a square circle,—hence it would seem best to retain the extensively employed “Pott's disease,” or, if a more scientific designation is required, to substitute spondylitis (*σπόνδυλος*, a vertebra) as being the least open to objection.

Frequency.—The frequency of this disease in surgical practice is exhibited in 5680 orthopedic cases, of which 1000 were tuberculous, treated at the Hospital of the University of Pennsylvania and Polyclinic Hospital, of which 492 were cases of this affection. These were taken from 22,214 cases of all kinds, of which Pott's disease represented 0.018 per cent.

Relative Frequency.—The relative frequency as regards other joints is shown in the following from my own statistics: Pott's disease, 416; hip-joint disease, 421; knee-joint disease, 103; ankle-joint disease, 33; shoulder-joint disease, 2; elbow-joint disease, 17; wrist-joint disease, 8.

Beuthner out of 78,297 patients found 280 cases of Pott's disease, or 0.36 per cent.; Lorenz out of 32,424 patients found 251, or 0.75 per cent.; and in 1444 cases of deformity treated by Hoffa, 142 were cases of spondylitis, or 9.83 per cent., and these were taken from 67,919 cases of all kinds, of which Pott's disease formed 0.21 per cent.

Localization of the Disease.—The erect position of the human body is a factor in the production of this deformity. It is asserted that spinal caries does not occur in quadrupeds. Davy suggests that caries "is possibly one of the penalties we pay for walking in the upright position," while Albrecht assumes that the upright position is the chief cause. Mohr, in 56 autopsies of osteitis of the spine, found the affection most common in the dorsal region (33 in 56 cases), next in the lumbar region (27 times), and next in the cervical (12 times).

In 100 consecutive cases taken in order of attendance from my private case-books, the following relative frequency was observed: 14 cervical, 50 dorsal, and 36 lumbar.

From collected statistics it would appear that the relative frequency with which the disease attacks different portions of the vertebral column is: 1, dorsal; 2, lumbar; and 3, cervical. In 286 of my own cases of Pott's disease there was the following involvement: dorsal, 190; lumbar, 80; and cervical, 16. Of the involvement of the dorsal region the relative frequency is as follows: out of 235 cases of dorsal affection there were 44 upper, 66 middle, and 125 lower, or 19 per cent. upper, 28 per cent. middle, and 53 per cent. lower.

In regard to the individual vertebrae affected, Billroth and Menzel found the order of frequency as follows: First and second cervical; sixth, fourth, and eighth dorsal; fourth and fifth lumbar; tenth and ninth dorsal; and the third cervical.

Etiology.

Age.—Pott's disease occurs at all periods of life; it is seen in infancy, youth, adult life, and extreme old age; Bryant has even described a case occurring in the fetus. By far the greater number, however, occur from three to fourteen years. Gibney found 87 per cent. under fourteen years of age, 7 per cent. between twelve and fourteen years of age, and 4 per cent. over twenty-one years of age.

The following table illustrates well the relative frequency at all ages:

PERIOD.	MOHR: 72 CASES.	DRACHMAN: 161 CASES.	TAYLOR: 375 CASES.	YOUNG: 429 CASES.
One to five years,.....	29 per cent.	41 per cent.	60.3 per cent.	41.3 per cent.
Six to ten years,.....	22 "	36 "	18 "	24 "
Eleven to fifteen years, .20	"	13.7 "	6.4 "	12.1 "
Sixteen to twenty years, 16.7	"	5 "		6.8 "
After 20 years,.....	11 "	4.3 "		15.8 "

The disease may be limited to one vertebra, or five or more may be affected. Thus, in the 81 cases collected by Bouvier, in 31 cases, one or two vertebrae were affected; in 26 cases, three, four, or five; in 24 cases more than five.

Sex.—Age is, therefore, a predisposing cause, while sex appears to exercise but little or no influence. Some authors agree in their opinions in regard to the influence of sex in the etiology of this affection; those who believe in a traumatic origin consider it more frequent in boys, from their presumed greater liability to injury. Fisher has found that out of 500 cases treated at the National Orthopædic Hospital, London, 261 were males and 239 females. Mohr, out of 137 cases, found 69 males and 68 females. Gibney, in 2466 cases, found 1329 males and 1126 females. Taylor, out of 412 cases, reported 234 males and 178 females. Bradford and Lovett, at the Children's Hospital, Boston, had in 294 cases, 152 males and 142 females. From the combined statistics collected from these sources there were 3797 cases, of which 2045 were males and 1752 were females. Allowing in this estimate for the preponderance of females over males in the population, it would make the disease appear equally common in both sexes, and correct the erroneous impression of a greater prevalence among males.

Heredity.—It is particularly frequent among the scrofulous, or those suffering from the condition known as strumous diathesis—a condition which, irrespective of external physical appearance or hereditary antecedent, renders the system peculiarly prone to chronic catarrhs, chronic inflammations of the bones, glands, and skin, retrogressive in character, occurring without adequate cause, and singularly liable to tuberculous infection; those in whom there is, in other words, a constitutional predisposition to caseation, or to a tuberculosis of irritated parts. This is particularly well shown in the association of Pott's disease with strumous and tuberculous affections in other parts of the body, such as "white swelling," caries or necrosis of bone, phthisis, etc., and in the antagonism, pointed out by Treves, which exists between such strumous disorders, by which two such affections are seldom manifest at the same time.

The infection of the lungs from the vertebrae has been denied, and one authority, Dr. T. J. Mays, has never seen phthisis associated with or subsequent to tuberculosis of the upper dorsal or cervical vertebrae. I have seen phthisis follow dorsal caries, and attribute it to extension through the bronchial glands, and I have also seen tuberculosis of the suprarenal glands associated with lower dorsal caries.

The tubercular diathesis and tuberculosis are, then, very important factors in the etiology of this affection, the former being the predisposition, the latter the actual infection. In this connection I should like to call attention to the large number of instances in which the tuberculous diathesis is transmitted by the father, and is exhibited in joint tuberculosis in the child without the mother becoming in the slightest degree infected.

In my own statistics in 416 cases of Pott's disease a hereditary tuberculous taint was found in 24 per cent., and in 185 cases examined by Gibney there were 76 per cent. with a hereditary tuberculous taint. Lorenz found in 251 patients 61 cases of heredity, and Vulpius 16 out of 96 cases.

Again, while the diathetic condition is important as a predisposing etiological factor, a history of traumatism is usually presented as a direct exciting cause; with this predisposition to chronic inflammation present in the system, a slight injury, or an undue use of, or pressure upon, certain parts, may initiate the disease. The various exanthemata, whooping-cough, and other depressing diseases of childhood are often directly responsible by lowering the vitality and permitting the progress of glandular disease and the dissemination of infectious elements.

The general etiology of tuberculous disease of the bones and joints has been considered in Tuberculous Joint Disease, in Chapter II, Part I.

Pathology.

The pathologic lesion peculiar to Pott's disease is a destructive osteitis terminating in interstitial absorption or caries, affecting the cancellous structure, and especially the anterior portion of the body; it may involve only one or several vertebrae. As a tuberculous lesion it does not differ from the tuberculous osteitis occurring in the epiphyses of the long bones, and consists essentially of a softening or medullization of the bone tissue, the various steps of the process (congestion, formation of granulation tissue, and degeneration and softening of the new formations, with pus formation, caseation, and bone absorption) following each other in slow succession. The primary lesion is usually in the

body of the vertebra, but it may begin in the lamina and arches. The primary lesion in the body spreads forward to the prevertebral ligament, from which it extends upward and downward. The tuberculous process spreads by contiguity, attacking the adjacent vertebrae above and below. In this manner several bodies of the vertebrae may be involved, the one which was the seat of the primary focus being most extensively affected. As the disease progresses the softening and absorption of the anterior portion of the vertebra render it incapable of sustaining the superimposed weight, and it is crushed and absorbed, in this manner producing angular deformity.



FIG. 204.—PHOTOGRAPH FROM SPECIMEN OF DORSAL POTT'S DISEASE, SHOWING KYPHOSIS AND DEFORMITY OF THORAX.

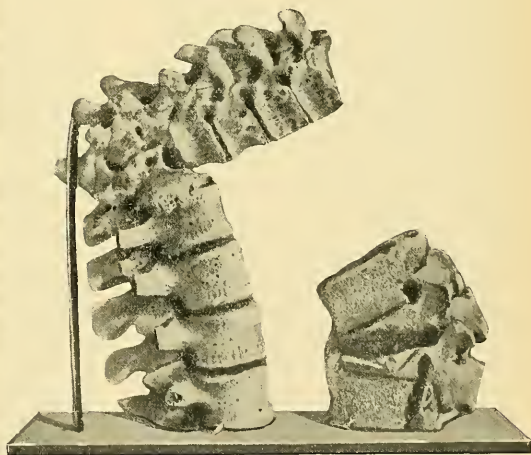


FIG. 205.—PHOTOGRAPH FROM SPECIMEN OF DORSOLUMBAR POTT'S DISEASE, WITH SECTION OF VERTEBRAS SHOWING ABSORPTION OF BODIES.

The character and extent of the kyphosis or deformity will depend upon the number of the vertebrae destroyed. If only one or two bodies are destroyed, the deformity is angular; and if a large number are diseased, the deformity will be a long posterior curve. When the disease is rapid, large sequestra may be entirely cut off by areas of granulation tissue, producing the so-called "caries necrotica." The necrotic form is accompanied, as suggested by König, by an infected tuberculous embolus, which is followed by an infarction process. The French have described the same process as tuberculous infiltration. The surrounding structure becomes firmer and the shape of the vertebra is preserved.

The adjacent bone is affected only by limiting and rarefying osteitis, and a cavity is produced which is not filled with granulation tissue, but which contains a piece of bone unchanged in structure. According to the degree of crushing of the bodies the angle formed varies, there being sometimes an obtuse angle, a right angle, or an acute angle formed.



FIG. 206.—SPECIMEN OF LUMBAR POTT'S DISEASE (Philadelphia College of Physicians).



FIG. 207.—SPECIMEN OF SEVERE FORM OF DORSOLUMBAR POTT'S DISEASE (Philadelphia College of Physicians).

Occasionally the tuberculous lesion is a superficial one involving a large number of vertebrae. In these the process may be rapid, pus formation usually occurs, and the vertebrae remain unaffected by the disease for a long period. The occurrence of primary tuberculosis in the arches is rare, but occasionally it is observed. The process resembles tuberculosis of the ribs, small sequestra

are separated and the arches are softened and friable. The destruction of the arches permits the column to bend laterally and scoliosis results.

The deformity may even be absent in the dorsal region, as in the autopsy reported by Spiller, in which a tuberculous mass $2\frac{1}{2}$ inches in diameter was found on the outside of the dura. The occurrence of deformity of the chest depends upon the location of the disease in the vertebrae. If the lateral portions are involved, and especially the attachment of the ribs to the vertebra, deformity of the chest will result. If only the body of the vertebra is diseased, deformity of the chest may be entirely absent.



FIG. 208.—CARIES NECROTICA, SHOWING CRUSHING OF ANTERIOR PART OF BODY (Specimen, Philadelphia College of Physicians).



FIG. 209.—CARIES SUPERFICIALIS AND CARIES NECROTICA IN SAME SPECIMEN, SHOWING DESTRUCTION OF BODY (Philadelphia College of Physicians).

Instead of being limited to the bodies of the vertebrae the intervertebral fibrocartilages and adjacent soft structures may be involved, or in exceptional cases it may be confined to the intervertebral substances. The destruction of the intervertebral bodies produces a peculiar deformity characterized by extreme bony projections which replaces the angular deformity usually present and which results from the depression of the vertebrae.

The term spondylolizia is applied to the deformity produced by caries

of the last lumbar vertebra (spondylarthrocace) and the top of the sacrum. The conditions are those of the spondylolisthetic pelvis greatly exaggerated. In this condition the angle of the kyphosis may be so acute as to cause the lower lumbar vertebrae to project over the pelvic brim like a roof.

In that class of cases in which the disease terminates in interstitial absorption (caseation without suppuration), designated as dry caries, or *caries sicca*, many vertebrae are generally involved, and the marked angular deformity



FIG. 210.—VERTEBRAL CARIES, SHOWING COMPLETE BONY OCCLUSION OF CANAL.



FIG. 211.—DORSAL CARIES, SHOWING ACUTE ANGLE FROM CRUSHING OF BODIES (Philadelphia College of Physicians).

is replaced by posterior curvature. As a rule, suppuration is entirely absent in these cases, but where they assume a suppurative phase, especially in adults, the course is usually more rapid.

Abscess.—In a considerable number of cases suppuration occurs, and abscesses form and find their exit in various situations, according to the location of the affected vertebrae and the resistance of the fascias. The collections of fluid vary in character and size, but do not differ from tuberculous abscesses elsewhere.

In order to re-establish the equilibrium of the spinal column compensatory changes occur above and below the deformity. When it is in the cervical region, marked lordosis of the dorsal region is a characteristic sequence and deformity of the cranial bones may occur. When the dorsal vertebrae are extensively involved, the ribs become misshapen, the sternum projects forward, and the pelvis becomes flattened. In connection with the formation of the kyphosis certain distortions of the aorta occur. This may be an acute V-shaped bend, or the aorta may be pushed by the abscess in various directions in a C- or S-shaped form. The angle may be so acute as to constrict or diminish the caliber of the vessel.

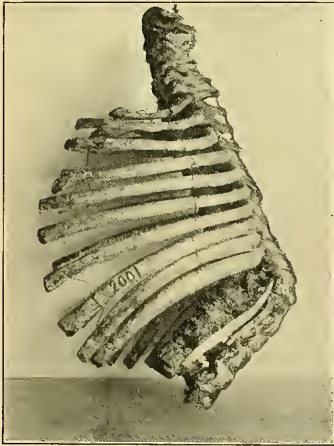


FIG. 212.—SPECIMEN OF DORSOLUMBAR CARIES (Wistar Institute of Anatomy).



FIG. 213.—LUMBAR CARIES (Wistar Institute of Anatomy).

The pathologic changes in the membranes and cord in the paraplegia which accompanies Pott's disease have been thoroughly studied. The disease is seldom the result of direct pressure, but ordinarily begins as a pachymeningitis externus, with extension by contiguity or irritation. The result of this is a thickening of the membrane, compression of the cord, and the establishment of a compression myelitis, which is usually the cause of the paraplegia. Compression may also be induced by the direct pressure of the vertebrae, obliteration of the canal, caseous deposits, sequestra, or abscess pressing upon the an-

terior surface of the cord. The paralysis may occur before the deformity from the mechanical pressure of an abscess. The bony canal is seldom narrowed by the deformity, and some specimens with extreme deformity are free from this complication, especially where abscesses occur and discharge upon the surface of the body. Dislocation of the odontoid process of the axis may occur. In 52 cases of autopsies collected from literature by Schmaus only 2 per cent. of the cases of compression were due to direct bony pressure from the deformity itself. The average proportion of the causes of the paraplegia was 78 per cent. from compression, and 22 per cent. from such causes as meningomyelitis, edema,

hemorrhage, sclerosis or diffuse softening of the cord itself. The compression was due in 66 per cent. to caseous tubercular pachymeningitis, produced by contiguity, and in 10 per cent. to dislocation of the axis.

When the violence of the process has exhausted itself the process of repair ensues, the vertebral bodies and arches become consolidated and protected against sudden dislocation by the deposit of fibrous tissue, caseous masses are absorbed or encapsulated or calcified by a formative or osteoplastic osteitis which, beginning early by the development of osteophytes from and in front of the bodies of the vertebrae, has locked together and fused them into firm, bony ankylosis. This process is the result of a superficial spondylitis. Beneath the anterior ligament, which acts as a periosteum, the pus spreads over many adjacent bodies of the vertebrae, producing numerous foci of tuberculous infection, and resulting in a

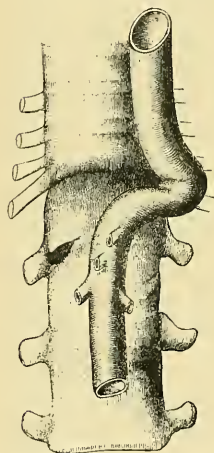


FIG. 214.—ANGULAR BENDING OF AORTA FROM POTT'S DISEASE (Hoffa).

roughening and grooving of the surface. The intervertebral bodies are sometimes softened and obscured.

Symptomatology.

Taken together, the symptoms of well-established Pott's disease are so characteristic that a diagnosis is possible almost at a glance, and yet few diseases in their incipency present such variations under so many phases as does this affection. There is present in the majority of cases a premonitory stage, often unobserved, the symptoms of which are included in the comprehensive term *malaise*—a condition between vigorous health and debilitating sickness,

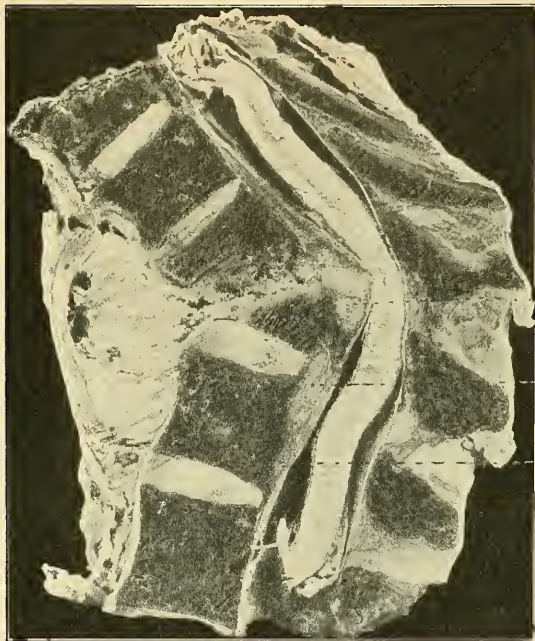


FIG. 215.—COMPRESSION MYELITIS FROM TUBERCULOUS MASS (Schulthess).



FIG. 216.—MICROSCOPIC SECTION OF CORD, SHOWING COMPRESSION MYELITIS FROM TUBERCULOUS MASS (Spiller).

a want of energy, an irritability, a lowering of all the vital functions, an inactive calm which precedes and premonishes the coming storm.

Muscular Spasm.—

Among the first and most important symptoms is a state of spasm or muscular rigidity of the spine. This is an early, always present, and persistent sign, due either to reflex muscular spasm similar to that constantly found associated with joint disease elsewhere, or an unconscious, automatic effort of the patient to avoid motion or prevent and diminish jar in the affected vertebrae; is a reflex, tetanoid spasm, accompanied by a specific atrophy,

especially of the erector spinae group of muscles, and exhibits itself in the

peculiar attitudes assumed, in the diminished normal flexibility of the spine, and in the slight lateral deviations of the column sometimes met in this disease.

Attitudes.—The attitudes assumed by sufferers from this affection are characteristic of the different parts affected. In the cervical region the most common attitude is one of wry-neck. In the cervico-dorsal region the neck is pushed forward and the chin elevated, the shoulders are drawn up, the spine below the diseased area being straight, or in a condition of lordosis. In



FIG. 217.—CERVICAL CARIES—FIRST AND SECOND CERVICAL VERTEBRAS.



FIG. 218.—CERVICAL CARIES—FIRST AND SECOND CERVICAL VERTEBRAS. POSTERIOR VIEW.

the dorsal region the spine is curved forward above and below the seat of disease, the shoulders are elevated, the body is shorter than normal, and the rigid spine gives a military attitude. In lumbar caries when the psoas is irritated, or a

psoas abscess is present, the patient stands upon one leg, the thigh of which is flexed, the body bent forward and one hand resting upon the knee. Children with cervical caries, when fatigued, grasp the head with the hands about the sides of the face; in dorsal caries they rest the hands upon the hip, or in sitting on a chair, upon each side, or leaning forward rest both hands upon the thighs. If a patient suffering from this affection be requested to pick up an object, as a coin, from the floor, instead of bending the spine directly forward, as a normal individual would do, he holds the spine rigid and flexes the knees and lowers the whole body in a squatting manner.

The diminished normal flexibility of the spine is best exhibited when an attempt is made to manipulate the affected part. In the cervical region if the head is carried by the hand of the surgeon toward the normal position the whole body will be carried with it. When dorsal caries is present, the child should be placed face down across the knees of the surgeon seated, with the arms and legs of the child hanging loosely down, and in this position the erector spinæ muscles will stand out prominently. In the lumbar region, if the child is placed face down upon a couch and an attempt be made to lift the body by the feet, instead of the spine arching forward it will be lifted rigidly *en bloc*. Slight lateral deviation is present in certain cases, especially the dorsal or



FIG. 219.—CERVICAL CARIES SHOWING EXPRESSION OF SUFFERING.

dorsolumbar regions, dependent upon undue muscular contraction or unilateral destruction of the vertebrae.

Pain.—Though cases are recorded where pain is entirely absent throughout the entire course of the disease, it is usually a prominent, distressing symptom:

the fallacy of the diagnostic value of local pain is now fully recognized. When present, it is usually deep-seated, dull, subacute, and intermittent, and, as a rule, experienced at the peripheral distribution of the irritated nerves, either at or below the affected spot, very rarely above it, except in some cases of cervical caries. It may be subacute, intense and lancinating, accompanied with hyperesthesia, or may only amount to an irritation. Thus, a stiff neck, laryngeal irritation, gastralgia, and pulmonary, intestinal, gastric, or cystic troubles, are frequently peripheral symptoms of a spinal caries.

Torticollis, occipital neuralgia, bronchitis, pneumonia, cystitis, and gastralgia are diseases frequently treated for this affection, and in one remarkable case lateral lithotomy was performed for supposed stone in the bladder, the



FIG. 220.—LUMBOSACRAL POTT'S DISEASE WITH LUPUS AND TUBERCULOUS DACTYLITIS.

autopsy of which exhibited lumbar caries. The writer has had related to him a case of caries supposed to be torticollis, where an attempt suddenly to correct the deformity resulted in sudden death. "Night cries" are of infrequent occurrence, but a peculiar "grunting" sound is frequently emitted by sufferers from cervico-dorsal caries.

Breath Catch.—In disease of the dorsal region there is sometimes present a difficulty in the respiration, which has been described as "breath catch." It is produced by a sudden arrest of expiration by the closure of the glottis, the sudden release producing a short, muffled, cough-like sound. It is probably a reflex spasm produced by the pain caused by the compression of the diseased vertebrae, or the costo-vertebral articulation. It disappears

upon assuming the position of recumbency and is most marked when the patient is fatigued from over-exertion. In cervical disease this is sometimes replaced by a grunting sound.

Deformity.—The posterior angular curvature is the most conspicuous, and often, especially in hospital practice, the first symptom which directs attention to the real seat of the disease; it results from the breaking-down of the vertebral bodies, the giving way of the anterior support of the column, and the projection backward of the spinous processes. As pointed out in speaking of the pathology of this affection, when but one or few bodies are involved, it is sharp and angular; when many, a long and gradual antero-posterior curve, the latter cases being usually of the *caries sicca* variety; when *angular* and *median*, it is a positive sign of caries. From the anatomic construction of the vertebrae the deformity will reach its greatest degree of development, and be most conspicuous, in the dorsal region. When the dis-



FIG. 221.—CERVICAL CARIES, SHOWING ATTITUDE.



FIG. 222.—ATTITUDE OF REST IN DORSAL CARIES (Hoffa).

ease is confined to a single vertebra, it alone may be prominent and the spinal column may preserve its normal outline above and below the prominence.

Angular curvature may be, and frequently is, absent in the cervical and lumbar regions. In many instances there is added to the lateral deviation a torsion of the vertebra in an opposite direction to that observed in scoliosis, thus, in Pott's disease, when lateral deviation is associated with convexity to the right, the rotation of the spinous processes would be to the right. Moreover, this deviation is a distinct leaning or acute bending of the body toward one side.



FIG. 223.—UPPER DORSAL POTT'S DISEASE.



FIG. 224.—MID-DORSAL POTT'S DISEASE.



FIG. 225.—LUMBAR POTT'S DISEASE.



FIG. 226.—DORSAL CARIES RECOVERED FROM PARAPLEGIA WITH LOSS OF SENSATION.



FIG. 227.—SEVERE KYPHOSIS
IN DORSAL CARIES.



FIG. 228.—LUMBAR CARIES, SHOWING CHARACTERISTIC
DEFORMITY. LATERAL VIEW.



FIG. 229.—LUMBAR CARIES, SHOWING CHARACTERISTIC
DEFORMITY.

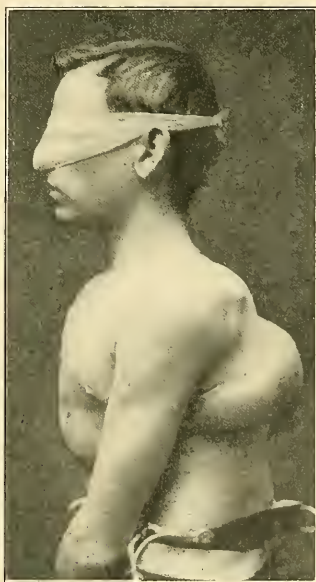


FIG. 230.—SEVERE POTT'S DISEASE. UN-
TREATED CASE.

The development of the deformity is usually gradual, but cases of rapid or even sudden appearance have been recorded, and indicate an active and progressive disease, or some sudden and unwonted action. With the occurrence of the angular projection in the dorsal region, the configuration of the anterior portion of the chest is likewise altered, amounting to a lateral flattening and "pigeon-breast."

Abscess.—The disease may run its entire course without suppuration, but in the majority of cases abscesses form a constant



FIG. 231.—LUMBAR CARIES, SHOWING LATERAL DEVIATION AND ALSO POSITION OF CICATRIX.

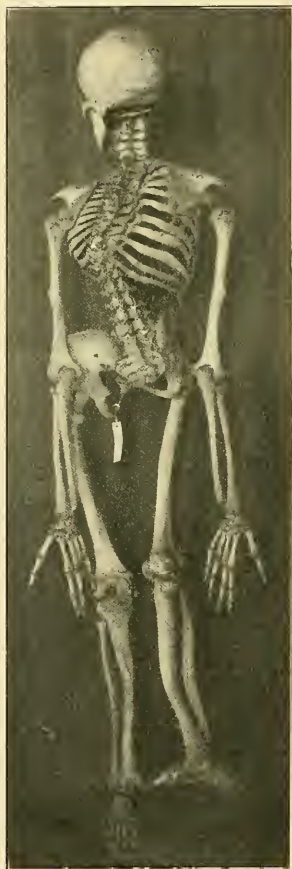


FIG. 232.—POTT'S DISEASE WITH LATERAL DEVIATION, FROM CARIES OF THE VERTEBRAS.

and important complication. In the former, caries sicca is the pathologic lesion, and a "residual abscess" results, as pointed out by Paget. As to the frequency of abscess formation, statistics vary. Nebel, in 54 patients suffering from Pott's

disease, found 24 abscesses, and, according to Taylor, abscesses developed in 14 per cent. of cases of kyphosis. In 61 post-mortem sections upon spondylitic patients, Mohr found 30 abscesses, and in 82 sections Nebel found 24 abscesses. Dollinger in 700 cases had 154 abscesses, of which there were 63 cervical cases with 13 abscesses, 407 dorsal cases with 47 abscesses, and 234 lumbar cases with 94 abscesses. The relative frequency of abscess in the different regions is well shown in the 183 cases of spondylitis reported by Parker, in which about 8 per cent. of the cervical, 30 per cent. of the dorsolumbar, and 70 per cent. of the lumbosacral cases suppurated. In general features the suppura-



FIG. 233.—LUMBAR ABSCESS (Hoffa).

tions that accompany are identical with the cold abscesses that result from caries elsewhere, and with the formation the usual apyretic course may be interrupted by an elevation of temperature, even reaching 105° F., as recorded by Schaffer. As a rule, however, there is but little constitutional disturbance—a slight rise of evening temperature, slight rigors, and perspiration. The temperature is variable and somewhat characteristic, even where an abscess cannot be discovered. There is usually a subnormal temperature in the morning with a slight rise in the evening temperature. It seldom goes below $98\frac{2}{3}^{\circ}$ or above $101\frac{1}{3}^{\circ}$ F. Any decided elevation and range of temperature would indicate the presence of suppuration, which is well shown in any chart from a case of spine disease with abscess. Locally, however, abscesses may occasion much disturbance from pressure and distention of surrounding parts, or may assume great size and remain stationary for long periods, especially in children, without occasioning inconvenience; these collections of pus follow the fascias in the direction of least resistance, and usually open at some

distance from the seat of origin; both the direction and termination will be determined by the region of the spine affected. The anatomic importance of the fascias in protecting important parts and organs is evident. Especial attention should be directed to the great importance of the cervical fascia, and to the importance of the fascias generally in determining the direction and pointing of abscesses from whatever cause.

Abscesses in the cervical region, when they open externally, pass between the longus colli and scaleni muscles to appear posterior to the sternocleidomastoid; they may, however, open into the posterior wall of the pharynx as a

postpharyngeal or retropharyngeal abscess, or may burrow beneath the deep fascia into the thorax and form a mediastinal abscess, discharging finally into the trachea,



FIG. 234.—PHOTOGRAPH OF A CASE OF BILATERAL LUMBAR ABSCESS, SHOWING SINUSES.



FIG. 235.—SAME CASE AS FORMER, SHOWING POSTERIOR DEFORMITY AND LATERAL SINUSES.

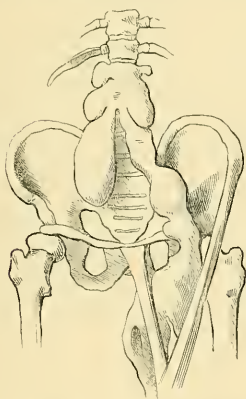


FIG. 236.—LUMBAR AND PSOAS ABSCESS (Hoffa).

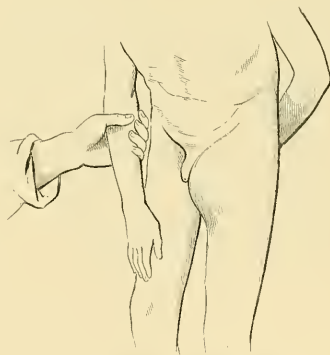


FIG. 237.—PSOAS ABSCESS (Hoffa).

esophagus, or through an intercostal space. In rare instances, as in a recent case of the writer's, the pus may penetrate the pleura and form an empyema.

In the dorsal region they burrow posteriorly to open on the back or side a short distance from the spine, or gravitate beneath the ligamentum arcuatum internum within the sheath of the psoas magnus muscle, and beneath Poupart's ligament, to appear externally in Scarpa's triangle as a psoas abscess.

The external opening on the dorsal aspect may communicate directly with the lung, as was illustrated in a boy under my care, in whom iodoform

emulsion injected into the sinus was expectorated with violent coughing.

In rare instances a psoas abscess may find its exit through the obturator foramen and discharge through the saphenous opening.

In the lumbar region, owing to the peculiar anatomic conditions, purulent collections vary much in their course and exit. It will be observed in examining a sectional diagram of the lumbar region that the sheath of the psoas muscle and the lumbar fascia are the most important structures in this connection. The sheath of the psoas is a thin, fibrous membrane derived from the iliac fascia, attached above to the ligamentum arcuatum internum, laterally by a series of arched processes to the intervertebral substance and prominent margins of the bodies of the vertebrae, becoming below continuous with the iliac fascia. The lumbar fascia



FIG. 238.—LUMBAR CARIES WITH PSOAS ABSCESS.

divides into three layers, inclosing the quadratus lumborum, multifidus spinæ, and erector spinæ muscles, and giving attachment to the internal oblique. Its anterior and middle layers are attached to the transverse processes, and its posterior layer to the spinous processes. Above, its anterior layer is attached to the lower border of the last rib, forming the ligamentum externum. The posterior surface of the psoas muscle is separated from the quadratus lumborum by the anterior layer of the lumbar fascia—a very thin

fascia—but the greater part of the muscle is firmly supported behind by the erector spinæ muscle. In front, the quadratus lumborum is very thin and

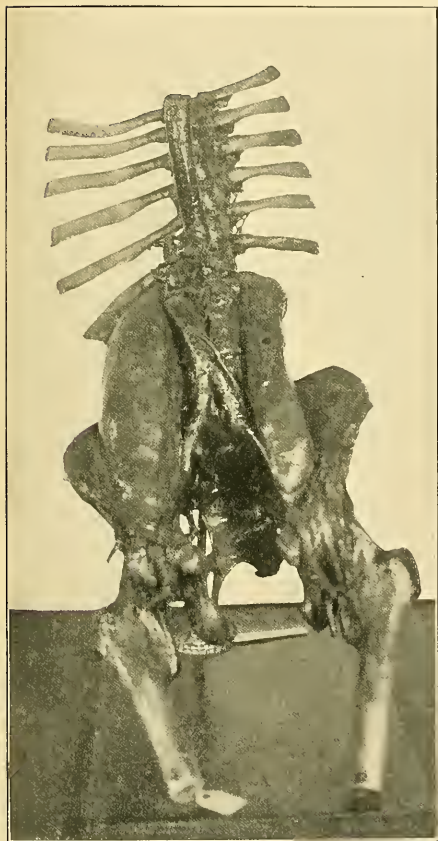


FIG. 239.—DOUBLE PSOAS ABSCESS.



FIG. 240.—LOWER DORSAL CARIES WITH LUMBO-PSOAS ABSCESS, SHOWING CICA-TRIX FROM INCISION.

offers but little resistance to the exit of the pus. The sheath of the psoas and the lumbar fascias, thin as they are, nevertheless are essential factors in determining the direction, and with the direction the prognosis, of lumbar abscesses.

So important do these fascias appear to the writer that he has suggested a division of lumbar abscesses into *external abscess* and *internal abscess*, their relation to the sheath of the psoas fascia and the anterior layer of the lumbar fascia determining their position. They may pursue a course like that of the psoas abscess and terminate similarly; may burrow backward and laterally along the middle layer of the lumbar fascia, separating the quadratus lumborum from the internal oblique, through the internal oblique and between the external oblique and latissimus dorsi, to appear at the outer border of the erector spinæ muscles, in the triangle of Petit, constituting lumbar abscess; may gravitate beneath the internal iliac muscles over the posterior brim of the pelvis, perforating the great sacrosciatic foramen as a gluteal abscess; or, if the abscess find exit upon the surface of the vertebrae anterior to the attachment of the psoas fascia, it will terminate by burrowing along the great vessels, or become an iliac abscess, to again terminate as a gluteal abscess. After becoming an iliac abscess, the pus may rupture into the intestines, bladder, vagina, or rectum, and I have seen a case of fistula in ano which had resulted from a spinal abscess.

These represent the usual classic courses, but cases are reported in which the pus has traveled great distances and discharged into the viscera or external parts remote from the seat of origin.

ORIGINAL TABLE OF SPINAL ABSCESES.

VARIETY.	COURSE.	EXIT.
Cervical	a. Anterior. b. Burrow beneath deep fascia into thorax as mediastinal abscess. c. Laterally between the longus colli and scaleni muscles.	- Into posterior wall of pharynx. - Into trachea, esophagus, or through an intercostal space. - Posterior to the sternocleidomastoid.
Dorsal	a. Burrow posteriorly. b. Within psoas sheath.	- On the back or side a short distance from the spine. - Beneath Poupart's ligament in Scarpa's triangle.
Lumbar	a. Enter psoas sheath. b. Burrow between the fascias of the quadratus lumborum and abdominal muscles, through the internal oblique. c. Gravitate beneath the internal iliac muscles over the posterior brim of the pelvis, perforating the great sacro-sciatic foramen. d. May be directed to the iliac region along the aorta and external iliac arteries.	- As psoas abscess. - Posteriorly beneath the external oblique and latissimus dorsi at the outer border of the erector spinæ muscle. - As gluteal abscess. - As gluteal abscess.

Paraplegia.—The paraplegia of the lower extremities which so frequently accompanies and complicates the disease, especially in the cervico-dorsal region,



FIG. 241.—DIAGRAM OF LUMBAR FASCIA (Deaver).

must be distinguished from that which results from compression of the spinal cord in cases of extreme distortion; it involves generally only the motor area



FIG. 242.—SPASTIC PARAPLEGIA IN POTT'S DISEASE.

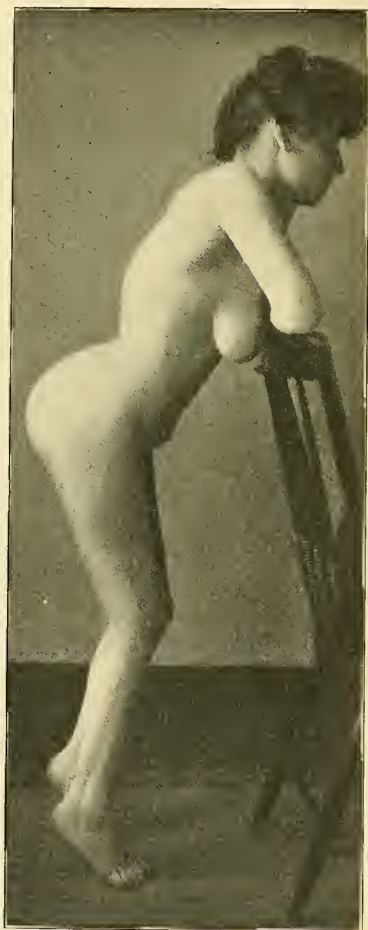


FIG. 243.—POTT'S DISEASE WITH SPASMODIC PARAPLEGIA.

of the cord, and occurs in the acute stage of caries from reflex paralysis due to some obstruction to the blood-supply, or to communication of the inflammatory

action by contiguity from the seat of the disease to the peri-meningeal areolar tissue and membranes of the spinal cord—a pachymeningitis, or meningo-myelitis. The symptoms are those of a compression myelitis—gradual loss of power, with increased reflexes, exaggerated patellar reflex and increased ankle clonus in the early stage, followed by complete loss of power, contracture of muscles, atrophy of paraplegic parts, and loss of sensation in the later stages. In some instances after the loss of sensation there occurs a stage of spasmodic contractions of the entire lower extremities, the limbs being in a condition of spastic rigidity. Should the power return while this condition remains, the scissor-leg deformity present interferes greatly with the progression. The general health is but little affected, and the bladder and rectum are not disturbed, except when the lumbar portion of the cord is involved, or toward the end in very severe cases. In severe types where incontinency is marked, priapism and cystitis, with pressure bedsores and septicemia, add to the distress of the sufferer. The average duration before the appearance of paralysis is about three years, although it has appeared as early as four and a half months, and as late as eleven years. The paralysis may remain stationary for a long period, and regression finally occur and progress to a complete recovery. In the 59 cases reported by Taylor and Lovett, the duration was never over three years, except in one case, where it lasted for six years. Recurrence was observed in 6 cases, 4 cases having two attacks, and 2 having three attacks. It occurs in any number of consecutive cases in about the same proportion (being somewhat modified by early treatment), but much more frequently complicates the disease in the upper than in the lower part of the canal, for obvious anatomic reasons. Thus, in the analysis of 295 patients suffering from Pott's disease, Gibney found that paralysis occurred in 62 in the course of the affection, 59 of these complicating 189 cases of disease in the upper dorsal and cervical regions, and only 3 complicating 106 cases of the affection in the lower portion of the canal. Recovery follows under efficient treatment in many, even when sensation has been lost, and when it occurs is generally complete. Relapses may occur two or three times. The extreme distortion of the thorax may produce pressure neuritis of a severe type. In one patient the pain was so acute that I had to resect a portion of a rib for its relief. The same patient had in his youth a paralysis of one leg from lateral pressure.

Diagnosis.

The importance of an early diagnosis cannot be overestimated; to this



FIG. 244.—CERVICAL CARIES—FIRST AND SECOND CERVICAL VERTEBRAS. SKIAGRAPH.

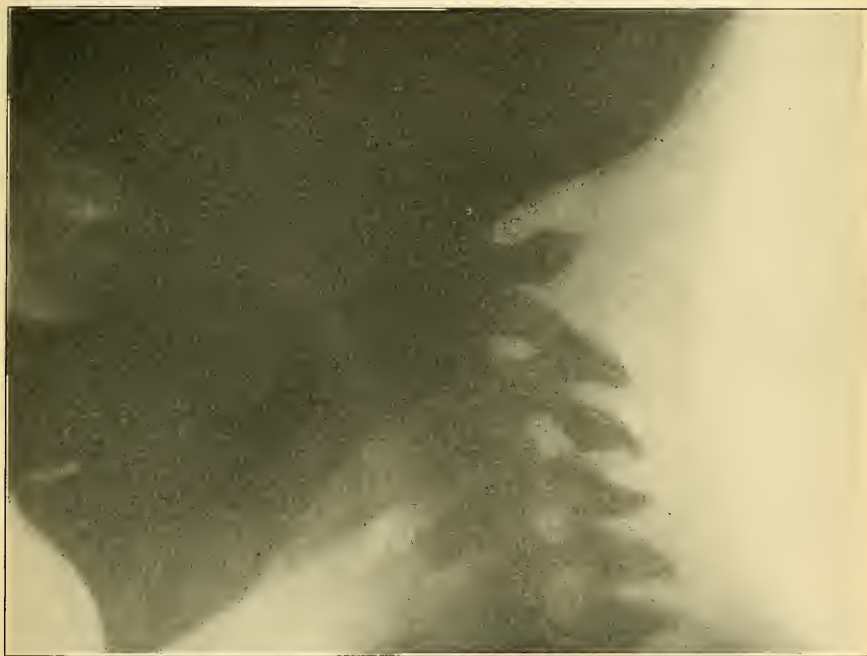


FIG. 245.—CERVICAL CARIES—SECOND CERVICAL VERTEBRAS (SKIAGRAPH). LATERAL VIEW

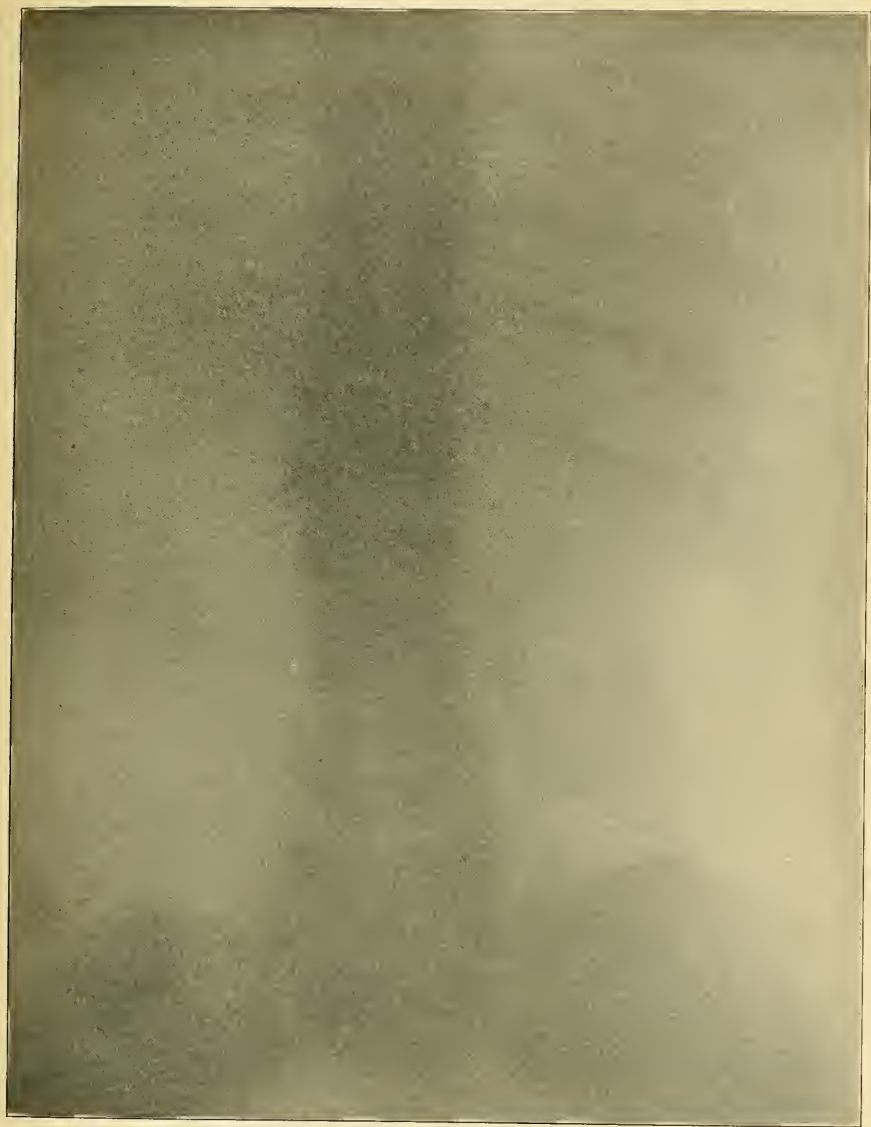


FIG. 246.—SKIAGRAPH OF LOWER DORSAL CARIES.

end the examination, both oral and physical, should be most thorough and painstaking. The entire back should be exposed in good light, and the flexibility of the spinal column tested, either standing, by the method of Adams (by placing the heels together, the lower extremities extended, and the body flexed as far forward as possible), or prone upon a hard couch. In children the latter position is the better. The surgeon places his left palm upon and fixes the pelvis, and grasping the feet with the right hand, flexes the knees, and ascertains the amount and range of flexibility. In small children a high degree of flexibility should be present. In obscure cases this examination should include the inspection of the pharynx, accurate measurements, and electric and other reactions of the extremities, examination of the major articulations and the temperature.

X-Ray Photography.—The examination of the spine by means of the x -ray is of great value. Not only can the amount of disease and the character of the lateral deviation be determined, but in some instances the abscess may be distinctly outlined, if present, as in the x -ray of the cervical region on page 237. The extent of the disease in the vertebrae may often be very clearly demonstrated by this means, and the spreading of the disease to adjacent vertebrae may sometimes be discovered.

The size and course of large abscesses may be outlined by the use of substances thrown into their cavities, but these methods are not of much practical value.

Differential Diagnosis.

There are so many diseases which have been mistaken for this affection that the examination should consist essentially of a differential study (1) of the spinal deformity, (2) of the cord and nervous symptoms, and (3) of the abscess, or of all three conditions if present.

The Differential Diagnosis of the Deformity.—The kyphosis is characterized by its angularity, median position, and rigidity; so marked are these peculiarities that confusion with lateral curvature is not likely to ensue, except in those cases of Pott's disease where there is marked lateral deviation. These, as pointed out before, are chiefly muscular, and are accompanied by an exacerbation of all symptoms, which with the rigidity of the spine would serve to distinguish them. Aneurysms of the thoracic and abdominal aorta eroding into the vertebral bodies give rise to symptoms characteristic of caries, as in cases recorded by Quinke and Roberts; but, in addition, the symptoms

of aneurysm would be associated, and the extensive curve, localized pain, and late period of life at which they occur, would render the diagnosis patent. The same considerations would eliminate carcinoma, sarcoma, and other malignant growths. For the differential diagnosis of scoliosis, sarcoma of the spine, syphilis, typhoid spine, and phosphorus necrosis, the reader is referred to the chapter in which they are considered. Rheumatoid arthritis of the spine, or spondylitis deformans, is characterized by its occurrence late in life, stiffness and arching of the spine, and the absence of kyphosis, abscess and muscular spasm. Vertebral osteomyelitis is characterized by acute onset, rapid suppuration, rigors, remarkable febrile alterations, rapid pulse and respiration, diarrhea, etc., and extensive denudation and destruction of the vertebra. A differential diagnosis from functional spinal debility, rachitic curve, etc., is easily made and need not be dwelt upon here. In young children muscular rigidity and local pains over the vertebral articulations may be present in rachitic curves to a marked degree, but the curves are longer, less angular, more flexible, and *always* associated with other evidences of rickets. The presence of pseudo-palsy from periosteal tenderness may render the diagnosis more difficult.

The Differential Diagnosis of the Paraplegia.—The cord and nerve symptoms will, in the majority of instances, be found associated with marked kyphosis, or at least rigidity of the spine. In those rare cases in which paraplegia occurs without angular deformity, the latter symptom, and possibly a purulent collection, will assist the diagnosis. It is, however, in those neuromimetic, or so-called “hysteria of the spine,” that the greatest difficulty is encountered, and especially when associated with “hysterical paraplegia”; here the hysterical simulation closely resembles the genuine disease, but the pain is localized posteriorly and apparently acute; there is no reflex spasm; the muscular rigidity yields under gentle, firm pressure; and the paraplegia is usually sudden. It occurs usually in young neurotic women of pronounced brunet type, and there is usually associated ovarian tenderness, the globus hystericus, and other evidences of this condition. From hysterical, hyperesthetic, or neuromimetic spine the same conditions would aid in differentiation; but the absence of bony deformity, the exaggerated localized tenderness and pain, and, as a rule, the absence of real muscular spasm will render the nature of the affection patent. In the neurasthenic spine sometimes observed in youth, the muscular spasm, paraplegia, and occasionally kyphosis, are confusing, but the existence of spasms, contractions, and hyperesthesia in other portions of the body, and the general hysteria

will solve the problem. In severer cases, and after railway injury, or ligamentous traumatism from any cause, excessive muscular spasm is induced by flexion. In a recent case of this character without medicolegal interest, in an eleven-year-old girl, the history of injury and subsequent suffering, the absence of deformity, the excessive spasm and atrophy of the erector spinæ group of muscles, rendered the diagnosis clear. From muscular rheumatism, lumbago, etc., it is distinguished by a history of associated rheumatic affections, the diffuseness and extent of the pain, and the later period of life at which the rheumatic affections occur.

There are, moreover, several affections commonly mistaken for Pott's disease which deserve more thorough consideration. They are hip disease, sacro-iliac disease, and infantile paralysis.

Differential Diagnosis of the Abscess.—The abscess accompanying Pott's disease may be diagnosticated from purulent collections from other causes and neoplasms in general. In the cervical region it is liable to be mistaken for simple abscess and adenitis. The former are usually acute, attended with fever, and superficial in character. In the latter the inflammation is circumscribed, deep-seated, and unattended with the characteristic spastic sensation.

In the dorsal region chronic pleurisy with effusion or empyema, other inflammatory pulmonary affections, and malignant growths are to be distinguished by the physical signs. In the lumbar region abscess must be distinguished from simple chronic abscess, abscess of lumbar glands, abscess from caries of the ilium, perinephritic and pericecal abscesses. The condition of the psoas muscles will best indicate the presence or absence of pus within its sheath. In simple chronic abscess the symptoms of systemic disturbance are marked rigor, hectic fever, night-sweating, while those of vertebral caries are negative. Perinephritic and pericecal abscesses are distinguished by the



FIG. 247.—POTT'S DISEASE WITH HIP-JOINT DISEASE RESEMBLING SARCOMA OF SPINE.

marked local symptoms, some disturbance of the organ about which the pus has collected, the condition of the psoas muscles, and the absence of all the characteristic manifestations of Pott's disease. When the abscess opens into and is discharged from the vagina, an attempt may be made to distinguish it from the blennorrhœa infantilis by the examination of the pus for bacilli of tuberculosis and for gonococci.

The psoas abscess pointing below Poupart's ligament to the outer side of the femoral vessels may be mistaken for the abscess of hip disease, femoral hernia, cancerous tumor, bubo, fatty, cystic, and other fluctuating tumors; varicose saphenous vein, aneurysm, hydrocele of the inguinal canal, undescended testicle, etc.; the differential diagnosis of which may be rendered clear by the characteristic signs of each of these affections, and the absence of the positive



FIG. 248.—TESTING FOR PSOAS AND LUMBAR ABSCESS IN POTT'S DISEASE.

signs of spinal caries. The difference between the abscesses of hip disease and those of spondylitis is well shown by the tables on pages 232 and 319.

Caries of the last lumbar vertebra is often mistaken for osteitis of the hip, and vice versa. The differential diagnosis is at times exceedingly difficult to make, and for details the reader is referred to the chapter upon Hip-joint Disease. Sacro-iliac disease may be distinguished, if occurring in young adults, by the position of the swelling over the sacro-iliac joint, pain caused by pressure of the sides of the pelvis together, and the absence of lumbar spinal deformity. The differential diagnosis of lumbar Pott's disease from hip disease and sacro-iliac disease is well shown in the accompanying original table:

	COXALGIA.	LUMBAR POTT'S DISEASE.	SACRO-ILIAC DISEASE.
Occurrence, ...	Children under 12 years.	A disease of childhood.	Young adults.
Pain, ...	In knee or hip-joint.	Referred to peripheral distribution of lumbar nerves.	Localized over sacro-iliac joint.
Limb, ...	Apparent elongation of limb, adduction followed by real shortening.	No elongation of limb.	Elongation only of limb.
Buttocks, ...	Early loss of gluteo-femoral fold.	No change in buttocks.	No change during early stage. Late obliteration of gluteo-femoral fold.
Movements, ...	Limited flexion and extension first sign.	No restriction of movements in hip-joints.	No restriction of movements when pelvis is fixed.
Pressure, ...	Pressure on sides of pelvis without pain.	Pressure on sides of pelvis without pain.	Pressure on sides of pelvis causes severe pain.
Deformity, ...	Swelling and induration about trochanter.	Angular median deformity of lumbar spine.	Swelling over sacro-iliac articulation.
Abscess, ...	Abscess sinuses lead to hip-joint.	Abscess sinuses lead to lumbar spine.	Abscess sinuses lead to sacro-iliac joint.

Infantile paralysis may be distinguished from the paraplegia of Pott's disease by the history, absence of rigidity or pain in the vertebral region, the muscular weakness and atrophy, and especially, in cases of doubt, by the electric reactions in the affected muscles, the description of which will be found in full in the chapter upon Infantile Spinal Paralysis.

Progress and Prognosis.

Contrary to the generally accepted idea, many patients recover from this affection, there being a natural tendency thereto. The cures achieved in modern times may justly be attributed to early diagnosis, better knowledge of the etiology and progress of the disease, and the skilful adaptation of mechanical measures. The progress depends much upon the portion of the spine affected, and will be influenced by the amount of personal attention and care given.

Although considering caries of the spine to be always a serious affection, I do not, nevertheless, deem life seriously imperilled thereby. Of those who receive proper care very few perish directly from the spinal condition. Of the hundreds of cases which I have seen, only a very few have died directly from this condition, the mortality being usually due to some intercurrent affection or to the disease of other organs. When unrecognized or neglected, it becomes one of the most formidable of affections—alike dreaded by the laity and shunned by the profession. The percentage of mortality in 269 cases collected from various sources was found to be about 27. They were as follows:

	CASES.	DEATHS.
Billroth and Menzel,.....	61	23
Jaffé,.....	82	22
Mohr,.....	72	7
Nebel, ...	54	18
	269	71

The mortality is always much greater in adults than in children.

The deformity may be diminished in some cases by appropriate treatment; but once present, it never entirely disappears. Nothing renders the prognosis more unfavorable than the occurrence of abscesses, especially when they exist for a long time and discharge at a point remote from the seat of disease. A fortunate result is most usual, however, when the abscess opens close to the affected vertebrae, and it has appeared to the writer that such cases do even better than where no abscess occurs. A cure may still follow after the abscess has opened and discharged for a considerable period, but abscesses which discharge for a long time are a drain on the vitality and a direct menace to life, owing to the ultimate amyloid and other degenerations of the internal viscera.

A "residual abscess" may become active at any, even a remote, time from the beginning of apparent cure of the vertebral lesion.

The paraplegia of Pott's disease, while a distressing and alarming complication, one which materially lessens the prospects of cure, tends, as a rule, to spontaneous recovery, the average duration being a little less than one year. This is well shown in the analysis of 58 cases by Gibney, 29 of which recovered, except one "still under treatment"; again, Taylor and Lovett report 19 cases, of which 17 recovered, 1 recovered partially, and 1 remained paralyzed; and Sayre has reported 38 cases either partially or completely paralyzed, of which 34 recovered and 4 remained under treatment. Relapses occur, but do not materially affect the prognosis. Exceptions to this favorable tendency are found in the paralysis in connection with caries, which is peculiarly apt to end in death; and where sensation and motion are both involved the restoration of the power of the limbs is only partial, or incurable paralysis persists. Even these cases are not hopeless, for cases of recovery after complete loss of sensation have been recorded elsewhere by the writer. The spasms and contractures which occur late in this disease are, in my experience, usually permanent.

A fatal issue may ensue from simple asthenia, the result of excessive suppuration, hectic pyemia, amyloid degeneration of the internal viscera, intercurrent affections—tuberculous or otherwise—rupture of an abscess inter-

nally, or from hemorrhage from perforation of a large blood-vessel. An interesting case of the latter is recorded by Ashhurst, where a psoas abscess



FIG. 249.—LAST STAGE OF POTT'S DISEASE, WITH DROPSY.



FIG. 250.—LAST STAGE OF POTT'S DISEASE, WITH DROPSY.

caused ulceration, and consequent rupture of a branch of the internal iliac artery, leading to rapid death. It may be safely said that more children perish from abscesses which open internally than from all other causes combined.

Mohr found in 9 cases of fatal abscess perforation into the esophagus in 2; pleura and lungs, in 2; pleura alone, in 1; peritoneum, in 1; and spinal canal, in 2. The prognosis as regards life, and the cause of death in persons cured of Pott's disease, are well shown in the 31 specimens studied by Neidert, at the Munich Pathological Institute. It was found that persons with slight deformity have as good a chance of life as normal individuals; persons with medium deformity die young of phthisis, while persons with severe deformity die of heart-failure or fatigue. The average age was forty-nine and a half years. Hypertrophy, with or without dilatation, of the right side will be found to be present in the large majority of individuals where deformity is present. In cervical caries death as sudden as in apoplexy may result where suitable support of

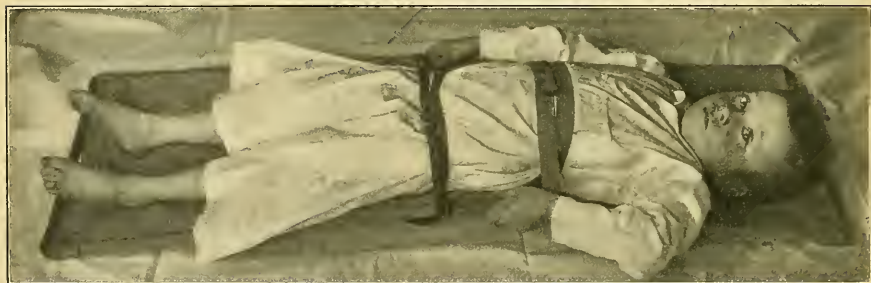


FIG. 251.—CANVAS FRAME FOR TREATMENT OF POTT'S DISEASE, SHOWING PATIENT IN POSITION.

the head has been neglected, as in two cases which I have observed on two occasions.

The prognosis is more favorable in children than in adult cases. The tendency to cure is marked, varying with the resistance of the individual and the situation and extent of the disease. Relapses are frequent where support has been discontinued too early. Speaking in round numbers, three years may be said to be an average time for a course of treatment, and the patient should remain under observation from three to ten years.

For years after the full growth has been attained, the exact height should be taken once a year, as suggested by Biggs, on the same date of the year, at the same time, immediately after rising in the morning, and under the same conditions, the rod of the machine resting upon the scalp in the parting of the hair, and any variation more than $\frac{1}{8}$ of an inch would be an indication to consider the resumption of a support.

Treatment.

Equipped with modern improved mechanical means, one approaches the subject of treatment of spondylitis with greater confidence than earlier writers could possibly have done. In addition, practical surgeons appreciate the important rôle which improved hygiene, in its widest adaptation, plays. In considering this section of the subject, the general medical treatment will be considered, and only such mechanical measures as have been found in the hands of the writer capable of meeting the requirements in the majority of cases. Nature is engaged in a local germicidal warfare, and well-directed assistance may enable her to conquer.

The general constitutional treatment has already been considered in Chapter II, Part I, tuberculous joint disease.

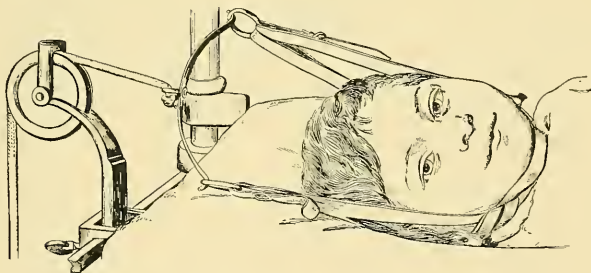


FIG. 252.—HEAD EXTENSION FOR POTT'S DISEASE.

Treatment by Recumbency.—Recumbency as a means of treatment still has its advocates. Prolonged recumbency with withdrawal from sunlight and fresh air has a deleterious effect upon the health. This form of treatment should be enjoined during the acute stage, and its evil effects may be obviated by the use of a light iron frame covered with canvas, to which the patient can be accurately fixed, with a canvas front and straps and buckles, and which permits of his being lifted and carried about readily. Such an oblong bed can be constructed, at a moderate cost, of light gas-pipe or stout steel bars. An apparatus of this character permits also of extension, counter-extension and fixation, a method of treatment of great advantage in cervical disease.

The deformity should be supported by small sand-bags or felt pads placed on either side of the kyphosis, and direct corrective pressure should be made by means of a bent bed-frame, the angle of the support being aided by the

weight of the body above and below the seat of the disease. The advantages of recumbency may be greatly increased by the employment of a special wheel couch in which the patient may be carried into the fresh air and sunshine. Of these there are many different forms. The one employed by the writer is shown in Fig. 135, page 149.

While in the recumbent position traction upon the spine should be made, in cervical and dorsal cases, by a head extension, of which there are many

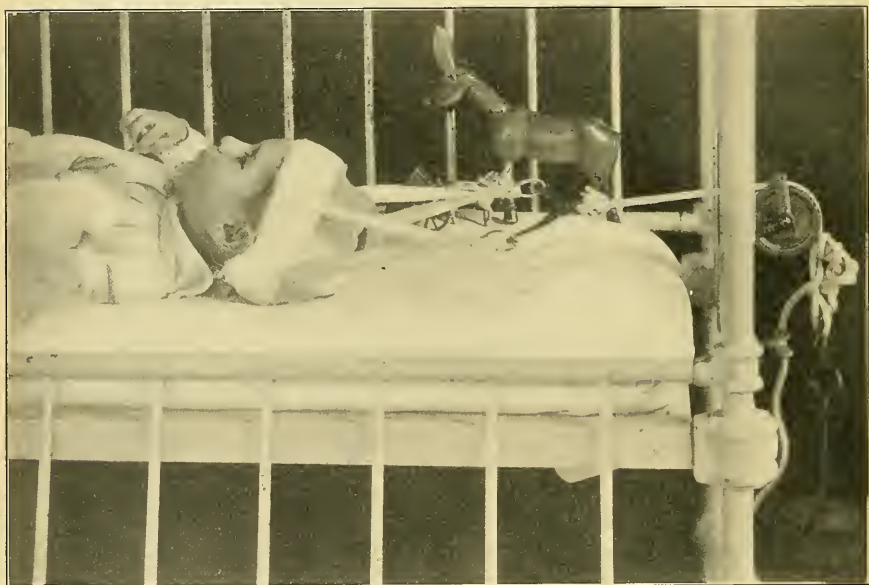


FIG. 253.—HEAD EXTENSION FOR CERVICAL CARIES.

forms in use; and in lumbar disease the traction should be made by adhesive plaster extension applied to the lower extremities. In severe forms of disease traction may be made from both ends at the same time. If the patient is restless or unruly at night, and straps and buckles are not used, the patient may be prevented from sitting up by a crib-net, which is securely fastened to the four posts and top rail of the crib.

In small children an exact *bas relief* of the body may be made with a plaster-of-Paris bandage applied to the back, or cream plaster poured upon stockinet,

with the patient in the supine position. After it has hardened and been trimmed it makes an excellent fixation apparatus.

Treatment by Suspension.—Suspension as a mode of treatment is an old plan which has recently been brought into prominence; it was employed as early as 1826 by Prof. J. K. Mitchell, of Philadelphia. Independent of support, as a remedial agent in uncomplicated cases, it has no special value. In paraplegia it is of distinct advantage, and will be described under the treatment of this complication.

Complete suspension can only be employed temporarily in securing a better position of the trunk for the application of plaster-of-Paris or other fixative apparatus, and great care should always be exercised therein. It is now recognized that the de-

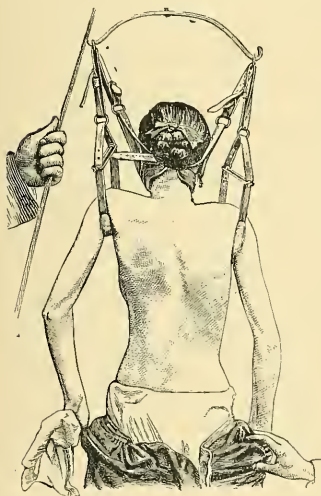


FIG. 254.—PATIENT SUSPENDED READY FOR THE PLASTER (Stimson).

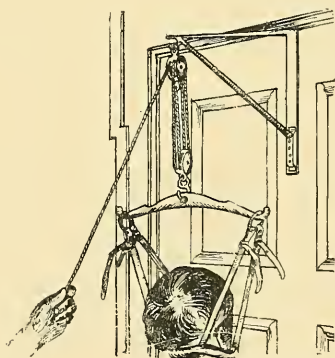


FIG. 255.—DOOR SUSPENSION FOR PLASTER JACKETS.

formity itself cannot be changed by the weight of the body alone. The vertebral column above and below the gibbosity may be extended and straightened, but the diseased area remains fixed. In fact, attempts to accomplish correction by complete suspension have been followed by immediate paraplegia and death.

Mechanical Treatment.—The machines and appliances employed are innumerable, but can all be classed in two groups: (1) The fixed jacket of plaster-of-Paris, and its modifications in silicate of soda, poroplastic felt, leather, woven wire, paper, bamboo, wood, etc.; (2) the spine brace.

The plaster-of-Paris jacket filled a long-felt want, and its various modifica-

tions have extended the range of its usefulness. When the patient is suspended by the neck, the rope should never be tied, but should be held by an assistant, as an accident or even a fatal result might occur in this manner. The technic of its application is so well known that it need not be dwelt upon here, but the method as now employed must be briefly described. The best material for the rollers will be found to be fine plaster, kept thoroughly dried, and cheese-cloth or butter-cloth. Stockinet in different sizes is more convenient than the knit shirts formerly employed, or an ordinary sleeveless woven shirt answers very well. In either case the garment must be a tight fit. The breasts must

be protected with cotton, and in some cases a folded towel may be placed over the epigastrium as a "dinner pad," to be subsequently removed. A piece of felt is placed on either side of the deformity and also over the crest of the ilium of each side. The patient is to be suspended until only the toes touch the floor, and the bandages, thoroughly wetted by placing singly on end in warm water until the air-bubbles cease to rise from the submerged bandage, and squeezed nearly dry, are to be applied quickly from below upward and well rubbed between each layer. In this manner a thin, neat, and strong cast should be obtained. The cast should be worked in above the crest of the ilium so as to give better shape and support. As soon as this is completed, the patient should be carefully placed in a recumbent position until the plaster has set, when the front should be cut down, the armholes trimmed,

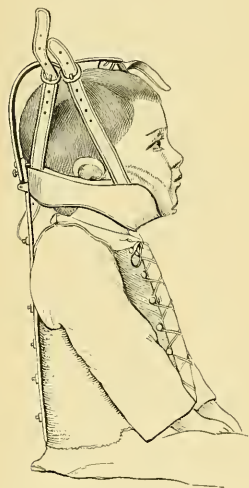


FIG. 256.—FELT JACKET OF BEELY
(Schreiber).

and the corset be bound and have the lace-hooks adjusted.

While possessing certain advantages of economy, requiring less special experience in its application, and being entirely beyond the control of the patient or attendants, there are certain positive disadvantages—the encircling of the body within a solid support; the inability to inspect the condition of the skin and note the progress of the affection; the formation of excoriations, ulcerations, and abscesses without the knowledge of the surgeon; the lack of cleanliness, etc.—which relegate it and its modifications to a secondary position. When split, furnished with lacings, and applied and removed at will, it loses part

of its efficiency, but there is a gain in comfort and cleanliness. It is of decided value, however, for patients who are unable to bear the expense of even the cheapest apparatus; in such cases, with attention to detail, a cure may often be effected, and the writer has in public practice frequently proved this statement, especially when the disease was located in the lumbar region. In all cases of disease above the seventh dorsal vertebra, a chin-rest should be added to remove the superincumbent weight, and more particularly to extend and fix the diseased area. The "jury-mast" is the head-piece generally employed with the plaster jacket, but is open to the objection that, while it supports, it does not fix the head. This may be accomplished by attaching it to two uprights fitted to the back of the head; or, better, by the use of the chin-rest, to be described later under the spine brace.

In justice to this mode of treatment, it must be added that there are certain cases in which it is the best and most efficient; this applies particularly to the lateral deviation of the spinal column present in certain cases of Pott's disease and in lower lumbar disease.

Correction of the Deformity.

Gradual Reduction.—At the present time there are several methods which aim at the gradual correction of the deformity by the employment of traction and pressure. The methods employed by Goldthwait, Taylor, Redard, and Schede are all upon the same principle and have all been followed by very satisfactory results. The different methods are so well shown in the illustrations that it is not necessary to describe them in detail here.

The leather corsets are prepared, over a counter-cast from the plaster-of-Paris jacket, from rawhide, untanned leather, or saddler's skirting. As manufactured by surgical-instrument makers they are ornate and durable, but entirely satisfactory leather jackets can be made by any practitioner. The adjustable wooden corset is more difficult to manufacture, but may be made by almost any one by attention to the details as given by the writer elsewhere in the section on General Orthopedics and as shown in the illustrations. It consists essentially of a wooden cuirass manufactured somewhat similarly to the felt and leather jackets, and composed of alternate layers of stockinet, wood, roller bandage, and linen, held intimately together with glue.

Spine Braces.—The spine brace should act on the principle of a lever, the fulcrum being the diseased part of the spinal column, the weight at the waist-band, and the power applied above to pull the part above the kyphosis

back as far as possible. The writer has personally had the best results with the antero-posterior support known as the Taylor spine brace, an apparatus constructed upon this principle. It consists of a pelvic band, upon which are attached two uprights of the best annealed steel, admitting of easy manipula-

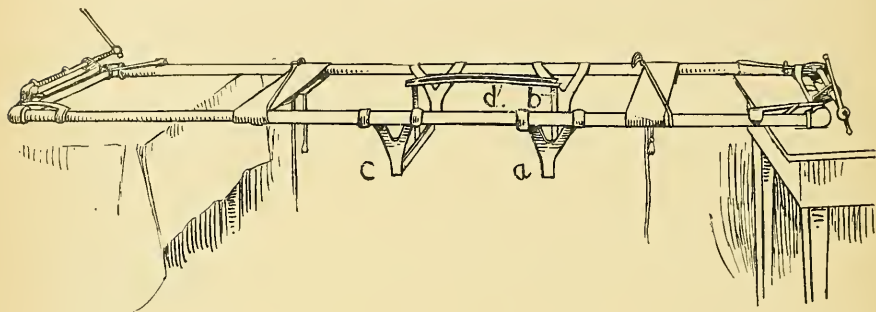


FIG. 257.—GOLDTHWAIT EXTENSION FRAME.

a, Bar suspended from gas-pipe frame; *b*, vertical rod; *c*, cross-bar; *d*, malleable steel bars.

tion and bending, connected with two transverse bars from which arise two shoulder-pieces. These uprights are separated sufficiently to rest, when applied, upon the transverse processes throughout the greater part of the spinal column



FIG. 258.—GOLDTHWAIT EXTENSION FRAME WITH PATIENT IN POSITION.

and at the seat of deformity; extending some distance above and below are the pad plates; the latter are pieces of softer steel fastened to the uprights by hinges and screws, admitting of ready removal and bending, and best covered with hard-rubber or ground cork inclosed in canton flannel. The shoulder-

pieces are provided with covered webbing straps, and the transverse bars and pelvic band with buckles. The apparatus is securely held in position by

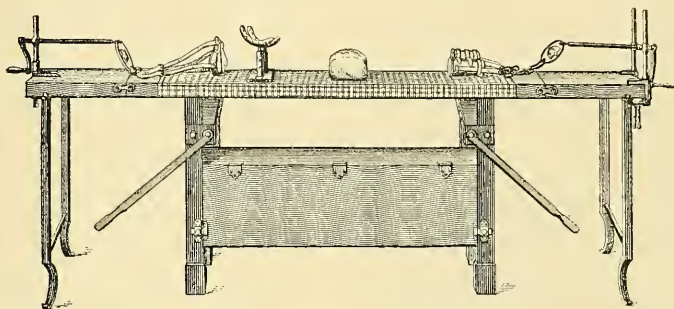


FIG. 259.—APPARATUS FOR FORCIBLE CORRECTION IN POTT'S DISEASE (Redard).

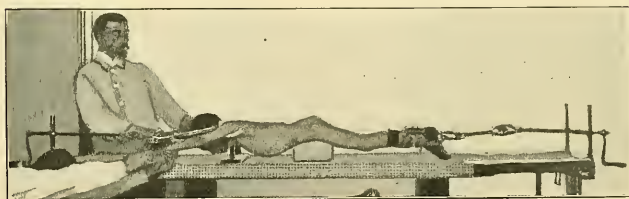


FIG. 260.—SAME SHOWING APPLICATION (Redard).

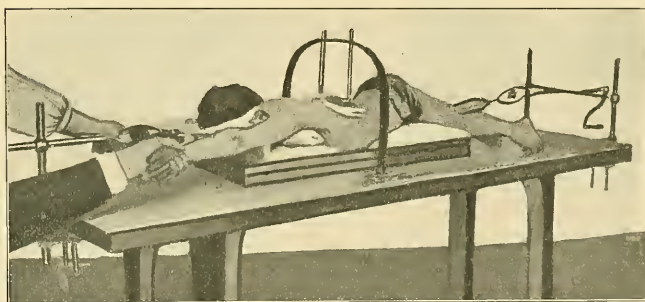


FIG. 261.—SAME, SHOWING PRESSURE PADS.

an apron of stout muslin and webbing straps. The patient is placed prone upon a hard couch and the measurements are taken with a lead strip, carefully

molded to the inequalities of the transverse processes, from the anal fissure below to the upper border of the scapula above. This outline, carefully traced upon stiff cardboard, is cut out, and serves both as a plan for the manufacture of the instrument and a record for subsequent reference. The pelvic band is measured from one trochanter to the other. The upper parts of the uprights are bent backward, so as not to rest upon the surface when applied in the recumbent position, but make gentle traction backward. The brace should always



FIG. 262.—SPINE BRACE FOR CERVICAL CARIES, SHOWING HEAD EXTENSION AND FELT FRONT.

be applied in the recumbent posture, the pelvic band be secured first, the axillary straps next, to the lower transverse bar, and, thirdly, the upper apron-strap to the buckles of the upper transverse bar. The middle straps of the apron are then secured over the uprights by means of safety-pins. In some cases of lumbar caries a swathe of plaster-of-Paris bandage, muslin, leather, felt, or celluloid will add much to the comfort of the patient and increase the degree of fixation

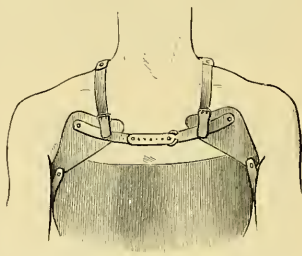


FIG. 263.—CHEST-PIECE FOR SPINAL SUPPORT (Taylor).

and pressure. Much ingenuity and variety may be displayed in the matter of pelvic bands, shoulder-straps, aprons, etc., but the principle of all is the same. Great care must be observed to so regulate the pressure on either side of the deformity as to secure fixation of the inflamed area without undue pressure.

The apparatus may be considered as having reached the limit of its efficiency if it makes the greatest possible pressure on the projection compatible with comfort and integrity of the skin.

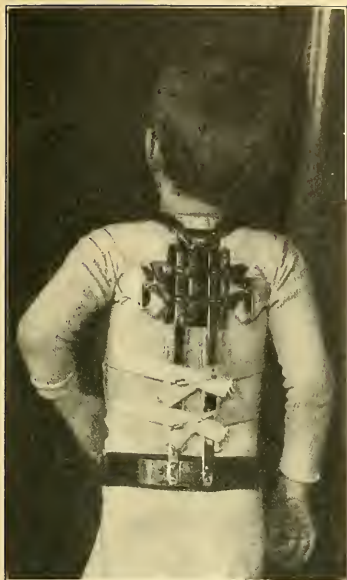


FIG. 264.—SPINE BRACE FOR DORSOLUMBAR CARIES.

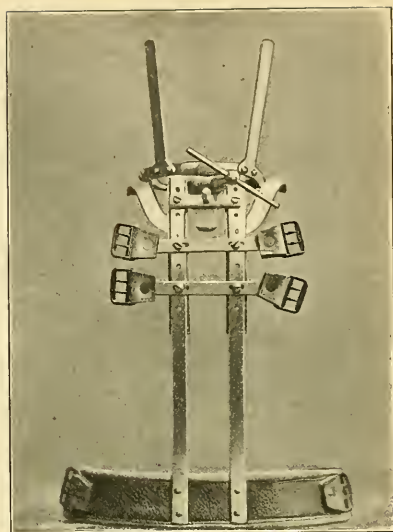


FIG. 265.—TAYLOR SPINE BRACE WITH CHIN-REST.

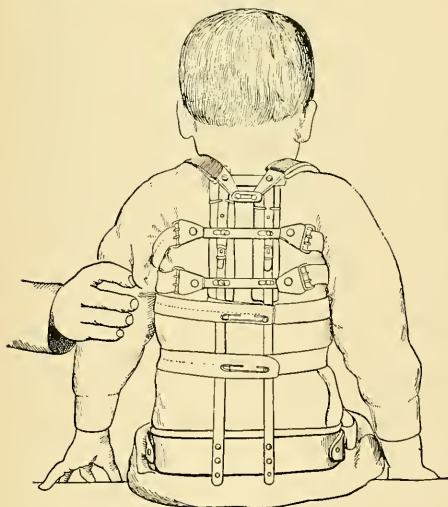


FIG. 266.—TAYLOR SPINE BRACE.

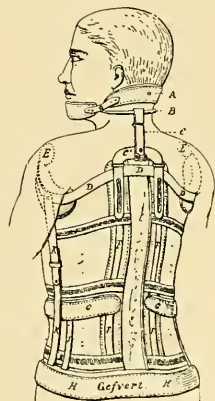


FIG. 267.—APPARATUS WITH CHIN-REST FOR POTT'S DISEASE.

a, Chin-rest; *b*, support; *c*, upright for chin-rest; *d*, upper bar; *e*, axillary crutches; *f*, uprights; *g*, pelvic band.

The apparatus must be worn day and night, unless some special complication calls for its removal, and under no circumstances should the patient assume the upright position without the support. In all cases where the disease is above the seventh cervical vertebra the apparatus must be supplemented by a chin-rest, to fix the diseased area and support the superincumbent weight; this consists of an ovoid steel ring, made to open on the side and secured when closed, arranged so that it can support the skin in a hard-rubber cup and exert pressure upon the occiput, and attached to



FIG. 268.—SPINE BRACE FOR DORSAL POTT'S DISEASE.

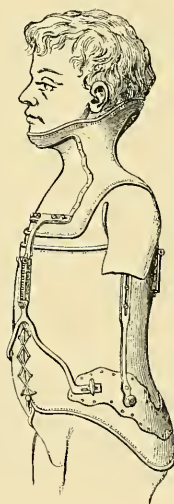


FIG. 269.—APPARATUS FOR CERVICAL CARIES—CAZIN AND LANNELONGUE (Redard).

the steel upright by a ball-and-socket joint, which allows of motion in all directions or can be fixed at any point. The head is secured by a webbing strap passing about the forehead from the extremities of the posterior uprights. In those cases before spoken of, where lateral deviation complicates the disease, it will be necessary to bend the brace up on one side and down on the other, and by enforced recumbency await the subsidence of the muscular spasm—or, removing the apparatus, apply a well-fitting plaster jacket with suspension,

and subsequently resume the use of the spine brace. In cervical cases the Goldthwait modification has proved efficient in my hands. The brace and head-piece are all in one piece, the latter being an extension upward of the spinal uprights.

Treatment of Caries.—When it is possible, efforts should be made to remove portions of the diseased vertebrae through incisions made for the escape of pus or by enlarging old sinuses. In the cervical region the bodies of the vertebrae may sometimes be reached by an incision along the posterior border



FIG. 270.—ANTERO-POSTERIOR SUPPORT WITH STRAIGHT BAND AND PLASTER-OF-PARIS SWATHE.

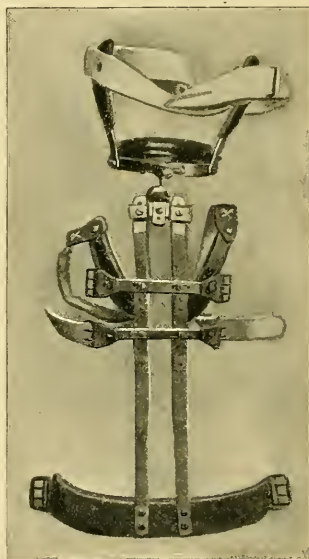


FIG. 271.—ANTERO-POSTERIOR SPINE BRACE, WITH CHIN-REST.

of the sternomastoid. An incision may also be made in the back of the neck. These incisions should follow the course of sinuses or should be at those points from which the seat of the disease is most readily accessible. The diseased bone should be removed with a curet as thoroughly as possible, great care being taken not to injure important structures. In the dorsal region the bodies cannot be reached unless the transverse processes and a portion of the rib are excised. This should be done if they are diseased, but such an operation is not advisable unless caries is present. The bodies of the vertebrae may

be cured, and in exceptional cases a drainage-tube may be passed around the front part of the vertebra. An operation of this nature, at which I assisted, was not of very great benefit.

In the lumbar region an incision should be made from the twelfth rib to the ilium, beginning $2\frac{1}{2}$ inches to the outside of the spinous processes. The dissection is then carried carefully down until the psoas is reached, when, some fibers of this muscle being carefully detached from the transverse process, the anterior surface of the vertebra becomes accessible and portions of it may be removed. This operation is sometimes spoken of as 'Treves' operation. It is a satisfactory operation, and in performing it I have been able to reach almost the entire surface of the bodies of the vertebrae.

The two most frequent complications—abscess and paraplegia—require special treatment.

The Treatment of Abscesses (Expectant).—Iliac, lumbar, and psoas abscesses are formidable complications. It has been the habit of surgeons to treat these expectantly—to allow them to open spontaneously. Where the abscess is small, stationary, and does not make pressure upon important organs, it will frequently be absorbed by fixation and recumbency.

Operative Methods.—Evacuation and hyperdistention of the cavity with various antiseptic fluids have been practised by a number of surgeons; but the operation did not fulfil all that was anticipated, and Demours and Demoulin, and Bradford and Lovett, have each recorded a death from it—two in all.

Under strict aseptic precautions the dangers of septicemia are greatly lessened, and in suitable cases—where the pressure effects and distention of the abscess demand urgent interference—free incisions, openings, and counter-openings, with insertion of drainage-tubes, should be advocated; particularly is this best where from the location and size it appears possible to remove by curetting the entire pyogenic membrane.

In retropharyngeal abscess and deep cervical abscesses burrowing toward the chest prompt surgical measures must be adopted. The former can be relieved by a guarded bistoury, or in some cases by the administration of an emetic; the incision should be made in the median line of the posterior wall

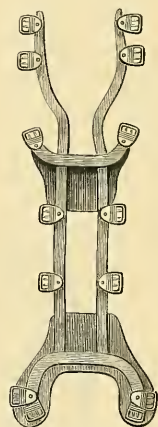


FIG. 272.—GOLDTHWAIT'S MODIFICATION OF TAYLOR'S BRACE (Bradford and Lovett).

of the pharynx, and the head quickly thrown forward to avoid suffocation or, what is decidedly better, the "Roser position," as recommended by Burrell, of Boston, with the head dependent over the end of the table, with a suitable mouth-gag. In this manner one does not have to make a plunge in the dark, but the apex of the abscess can be freely incised, and a free discharge of pus will take place through the mouth and nostrils. In deep cervical abscesses which are approaching the thorax along the deep cervical fascia, the plan of Mr. Hilton is best adopted. An incision should be made through the sternomastoid, an exploratory incision carried through the deep fascia, and if pus be found, the incision further extended.

In psoas and lumbar abscess through-and-through drainage should be established where possible, and in iliac abscess a portion of the rim of the ilium may with advantage be removed by bone forceps or trephine to permit thorough drainage.



FIG. 273.—LUMBAR ABSCESS, SHOWING CICATRIX.



FIG. 274.—INTERNAL LUMBAR ABSCESS, SHOWING PRIMARY AND COUNTER INCISIONS.

Operative Methods.—The operation advocated in these cases is performed under strict aseptic precautions. The abscess is opened by careful dissection, the incision being made in the direction of Poupart's ligament, half an inch to the inner side of the anterior superior spinous process. The external oblique muscle is divided in the direction of its fibers, and the internal oblique at right angles, or the fibers are separated. The contents of the sac are evacuated, and a long, heavy, grooved director or eye probe is carefully

passed up to a point above the sacro-iliac junction, and a straight longitudinal incision made upon it. The counter-incision in two of the cases reported was half an inch to the outer side, above the posterior superior spinous processes of the ilium. In one case, in which I was associated with Drs. Willard and Ashhurst, it was considered advisable to remove a portion of the crest of the ilium with a rongeur forceps, so as to permit the drainage-tube to lie flat in the iliac fossa. This appeared to facilitate the drainage and healing of the abscesses rather than to retard them.

The abscess cavity is thoroughly irrigated with sterilized water and boric-acid solution. A rubber drainage-tube is passed through it and secured by

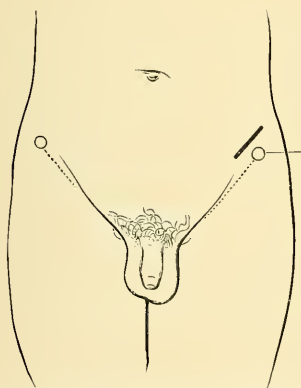


FIG. 275.—DIAGRAM ILLUSTRATING POSITION OF INCISION IN LUMBAR ABSCESS.

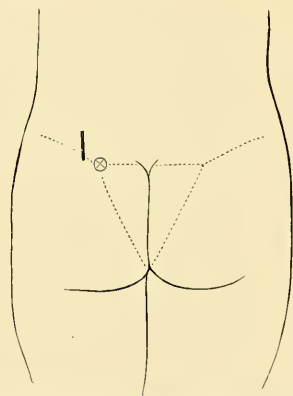


FIG. 276.—DIAGRAM SHOWING POSITION OF COUNTER INCISION IN LUMBAR ABSCESS.

safety-pins. This is allowed to remain in place for two or three days, after which it is gradually shortened. Half an ounce of a 10 per cent. emulsion of iodoform is introduced into the cavity, iodoform gauze packed about the wound, and a bichlorid dressing applied.

The indications for this operation are: (1) When the abscess is large and makes pressure upon important organs. (2) When the abscess is increasing rapidly in size. (3) When there is danger of rupture of the abscess into the peritoneal cavity. In the case of a psoas or gluteal abscess it is rarely possible to make a counter-opening, and to accomplish through-and-through drainage a rubber drainage-tube should be inserted into the cavity as far as possible, and the cavity irrigated daily or every

other day with boiled water and boric acid solution, followed by the use of the iodoform emulsion.

I have performed this operation many times and have never experienced any accidents, except upon one occasion, when in a case of psoas abscess while making the counter incision I opened the pleural cavity. This was immediately closed, and an opening made lower down, and the recovery was uneventful. When the abscess is not opened early and burrows beneath Poupart's ligament and opens on the front of the thigh, or gravitates backward on the thigh, it is necessary to make through-and-through drainage at this point also. In cases of this kind I have devised an original method of closing off the lower abscess by separate tubes and packing, and establishing through-and-through drainage at the points just indicated in the foregoing operation.

Before the abscess has advanced far enough to appear as a swelling in the groin, but still forms a sausage-like mass in the iliac fossa, it may sometimes be opened by a posterior incision. This incision should be parallel with the lumbar vertebrae and divide the quadratus lumborum muscle until the sac is reached. The sac may be made tense by pressure on the groin. My experience with this operation has been satisfactory, but I should always consider through-and-through drainage more thorough.

In all abscesses, after thorough cleansing with antiseptic solutions, a 10 per cent. emulsion of iodoform in oil should be injected, and a full aseptic dressing employed. A proper fixation apparatus will add much to the efficiency of any form of local treatment. I have myself seen a case of cervical caries, under the care of another surgeon, in which the fatal result could have been directly attributed to septic infection.

The Treatment of Paraplegia.—The management of paraplegia consists in recumbency, the accurate application of a spinal support, suspension, internal medication, and in advanced stages the employment of forcible correction or laminectomy.

Recumbency: The discovery of slight loss of motor power with exaggerated knee-reflex is the signal for recumbency. All those methods previously described under this subject should be employed.

Apparatus: Whatever form of apparatus is used it should be most thoroughly fitted. If the disease be in the cervical region, the body and head portion should be so made as not to permit of lateral motion. For this purpose I have had the best results from the use of a felt cuirass inclosing the body, neck, and head. This is made over a counter-cast which has been made from

a plaster cast of these regions taken with the patient in the prone position. In upper dorsal disease the neck should also be fixed, and in the lower dorsal and lumbar regions the apparatus should be carried as high as possible on the shoulders, and the scapulas be held by pressure pads.

Suspension: When the paralysis has advanced to the loss of sensation, benefit may be derived from vertical suspension, as applied by Charcot, Mitchell, Wood, and others. The suspension should be carried out daily for from ten to twenty minutes. This form of suspension is most useful in the treatment of adult patients, since



FIG. 277.—FELT SPINAL CUR-
RESS FOR POTT'S DISEASE.

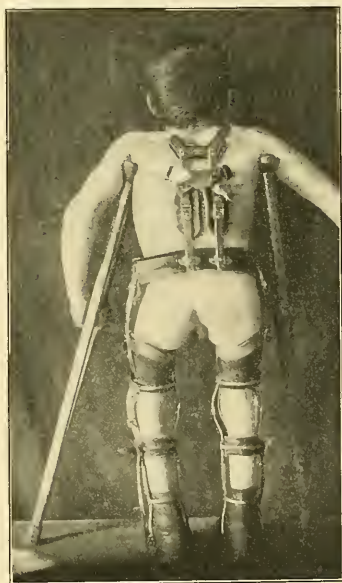


FIG. 278.—SPINE BRACE WITH PARALYSIS BRACES FOR SPASTIC CON-
TRACTION FROM POTT'S DISEASE.

the introduction of the horizontal backward extension by means of the bent tray has been found satisfactory in the treatment of children.

In connection with suspension the application of heat and cold alternately to the spine, as introduced by S. Weir Mitchell, will be found of signal service where there is complete loss of sensation. Hot compresses are applied over

the deformity for from three to five minutes, after which the part is rubbed with ice for the same length of time, each application being repeated twice. The effect upon the circulation of the spine through the application of heat and cold aids in the absorption of the edema and is frequently followed by marked improvement. Manual massage of the limbs and spine is not beneficial until after sensation has returned, and electricity is contraindicated in the earlier stages while spasm exists, but in the later stages seems to hasten the recovery.

Medical Treatment: The medical remedies which are used for tuberculous affections in other parts of the body are of equal benefit in the treatment of paraplegia, and there are certain drugs which are especially valuable. The use of large doses of potassium iodid is often found extremely satisfactory, and the best method of taking this is in liquid pepsin. The dose should at first be from five to ten grains three times a day, this being gradually increased until from twenty to sixty grains are taken thrice daily. The internal administration of mercury in the form of bichlorid combined with potassium bromid will be found useful, and may be alternated with the potassium iodid. The use of strychnin has been condemned by most observers in the treatment of paraplegia, and is contraindicated when there is muscular spasm. It is, however, distinctly advantageous when there is pain of a neuralgic character and when the muscular spasm is not great. The doses should be moderate,

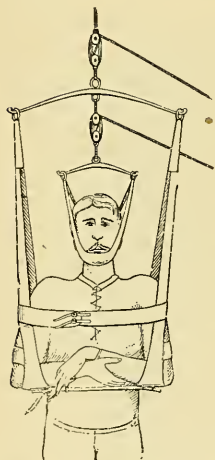


FIG. 279.—SUSPENSION FOR PARALYSIS IN POTT'S DISEASE.

$\frac{1}{100}$ to $\frac{1}{50}$ of a grain being given three times daily.

Patients should not be placed upon their feet too early after the return of motor power. The reappearance of ankle-clonus at any time during the course of the recovery would be an indication that the patient should be directed to resume the horizontal position, and the upright position should never be assumed until the ankle-clonus has entirely disappeared. The first efforts at walking may be assisted by a suspension apparatus, but crutches are not to be recommended, particularly in dorsal deformity, on account of the mobility of the scapula.

The effect of a change of climate upon the paralysis is variable, some

patients being greatly benefited while others appear to derive no benefit whatever from this method of treatment. A sojourn at the seashore is sometimes of advantage when the paralysis is due to an abscess pressing upon the cord; and under the influence of the salt air, there is frequently a disappearance of the paralysis, resulting from the absorption of the pus, the shrinking of the abscess sac, and the generally improved condition of the patient. Where the paralysis is due to other causes, as a tuberculous mass or bony pressure upon the cord, the seashore does not appear to be of any particular value, and a change to the country or mountains is preferable.

Forcible Correction: In order to remove the unsightly deformity caused by this disease the forcible correction described by such ancient writers as Hippocrates and Paré was revived by Chipault in 1895, and more recently popularized by Calot, in 1896. The operation as performed by him consisted in direct manual traction upon the deformity, and the reduction of the kyphosis by manual pressure, the amount of traction being estimated at from 60 to 160 pounds, and the pressure from 30 to 80 pounds. He reported 204 patients operated upon, with two deaths within two days and three deaths at a period subsequent to the operation. Partial paralysis followed in one case, and in another case an abscess developed shortly after the operation.

As a substitute for laminectomy the operation of forcible correction for paraplegia has a place in surgery in selected cases, and is particularly adaptable when the deformity is in the dorso-lumbar lower or middle dorsal region, but it is seldom required for deformity in the other parts of the spine. The cases which are most suitable are those in which the disease has not been of very long duration and in which the consolidation has not advanced to bony ankylosis. The presence of large abscesses is a contraindication. If the paralysis has existed for a year without any improvement under medical and mechanical treatment, forcible correction may be performed under an anesthetic, with the probability of benefiting this complication. The amount of force required is not so great as was recommended by Calot, as by using less violent measures the danger of damage to the surrounding structures may be avoided. The amount of force required should be determined by the yielding of the deformity, and two or more trials may be made before finally resorting to laminectomy.

In performing the operation of forcible correction the patient is prepared as for the application of a plaster-of-Paris jacket, in the prone position. An anesthetic is administered and the patient placed with the face down upon

a firm table. Traction is made upon the head by means of a bandage or leather head support, and upon each extremity by the hands of assistants, there being five thus employed. Gentle downward pressure is made upon the deformity by the right hand of the surgeon, while the left hand is placed beneath the body, the deformity gradually yielding, and the adhesions being broken. Felt pads are placed on either side of the deformity over the crests of the ilium, and a pad is placed over the epigastrium. Extension is maintained while plaster-of-Paris bandages are applied, and the cast is carried low over the pelvis, and includes the neck and head. Some surgeons use steel apparatus in addition to the plaster jacket. The cast should be worn for from four to six months, and the recumbent position should be maintained for from eight to twelve months.

The revival of this operation was signalized by the performance of a large number by many operators. The results of the operation have been carefully analyzed by Bradford and Cotton. They reported 699 operations by 34 operators. Of these, there were 25 deaths from all causes, five of which were attributed to the effect of the operation and the use of chloroform. In 23 where the paralysis was present before the operation, 17 were relieved, 2 were not relieved, and 1 was made worse; and in four instances the paralysis appeared after the correction. The direct effect upon the deformity by this operation in 224 cases was complete correction in 130, and incomplete in 194. The total result in 77 cases gave: some relapses in 50 cases, no relapses in 20, and total relapse in 7. Relapses may be attributed to too short a period of recumbency or to ineffective mobilization.

The experience which I have had in this operation leads me to consider it an unnecessarily severe procedure, and one liable to be followed by general tuberculosis, tubercular meningitis, paraplegia, abscess, rupture of abscesses, rupture of the pleura, and exacerbation of the tuberculous process. It has, however, served a useful purpose in so far as it has called attention to the possibility of gradual reduction of deformity.

Laminectomy: The operation of laminectomy, or trephining the spine, was revived by Macewen, and has been performed for the relief of paraplegia a number of times with variable success. In Pott's disease the operation is seldom required, and should be reserved until all conservative measures have been exhausted, and complete sensory paralysis has resisted all mechanical methods of treatment, unless the diagnosis of intraspinal abscess, tubercular masses, or a spicule of bone pressing upon the cord can be made. If any of

these forms of pressure may be removed, the operation will be of great benefit. The time when the operation should be performed will depend somewhat upon the pathology. In some cases the pressure of an abscess upon the cord is indicated by the symptoms. The angular deformity occurs early, before the signs of paralysis are manifested, or the paralysis after its institution will exhibit fluctuations due to changes in the tension of the abscess sac, and sometimes disappears suddenly from the bursting of the abscess and the relief of the pressure. When, however, the paralysis results from the pressure of a cheesy growth or an intraspinal abscess, it sometimes occurs prior to the advent of the deformity, and fluctuations do not occur, the disease progressing steadily toward the destruction of the spinal cord.

The operation should not be postponed until the cord has become completely disorganized, so that if the loss of sensation has existed for some time, with the occurrence of marked rigidity, the operation should be performed earlier. Improvement does not always follow immediately after the performance of this operation, and recumbency with traction should be continued for a considerable period.

The operation of laminectomy consists in removing the vertebral arches and opening the spinal canal. An incision over the arches to one side of the median line is made, the muscles and periosteum are reflected, and the arches are divided with rongeur forceps, great care being taken not to injure the dura. The cord should be carefully examined by means of a probe to see that all pressure is removed. If the cord does not pulsate, the dura may be opened and the examination continued in a search for masses of tuberculous matter. At the completion of the operation the wound is packed with sterile gauze and the patient is placed upon a water-bed or in the prone position. The gap which is left in the spinal column by the operation is filled with fibrous tissue.

The mortality of this operation is about 25 per cent., and this fact should be carefully considered, since these patients would otherwise live for years and might eventually recover. After recovery from this operation an apparatus should be worn for years, since the spinal column has been distinctly weakened by the removal of the arches, the anterior portion having been previously destroyed by disease.

CHAPTER II.

NON-TUBERCULOUS DISEASES OF THE SPINE.

KYPHOSIS.

Kyphosis is a deformity characterized by a posterior curvature of the vertebral column in part or in its entirety.

Synonyms.—*German*, Spitzbuckel; Winkelformige; Knickung der Wirbelsäule; Rückverbiegung der Wirbelsäule. *French*, Lordose. *English*, Spinal Excursion or Posterior Deformity.

Adolescent Kyphosis.—This affection is of very frequent occurrence, especially among young girls. It is more often found to be hereditary than is lordosis, and it is not so common as scoliosis, with which affection it is sometimes associated. Kyphosis in older persons is much more rare than in adolescents.

The deformity in this affection may be extreme. The kyphosis cannot be corrected by voluntary effort, and after a time it becomes permanent from compensatory osseous changes. It is most commonly met with in young women who have been overtaxed during adolescence in the field or workshop. The curve is generally in the dorsal region, but it may involve the entire spinal column or certain sections of the column. The usual characteristic physical signs are a depression of the anterior bodies of the vertebrae and the intervertebral discs, together with the separation of the transverse process and the contraction of the lamina. Deformity is more or less severe, according to the degree of the kyphosis, the vertebrae most frequently affected being the fifth, sixth, and seventh dorsal.

The diagnosis of kyphosis is frequently very difficult to determine. The prognosis is usually very grave, and the deformity resulting from the dorsal prominence becoming permanent is apt to be severe and unsightly.

The treatment consists in strengthening the weakened muscles, and in reducing and correcting the deformity by mechanical means. Some benefit may also be derived from forcible correction and fixation. A useful support is the Morton corset.

Round Shoulders.—When the shoulders droop forward and down-

ward there occurs what is familiarly known as "round shoulders." This form is very common in childhood and is the result of faulty attitudes assumed in school. It is also increased by the weight of shoulder-straps. The head droops forward, the chest is narrowed, the lumbar spine is arched forward, and the chest is sometimes flattened and sunken. But little attention has hitherto been paid to this very frequent deformity, and Lovett has noted that in all of the principal works upon orthopedics up to the present time there is only scant mention of this subject. Recently there has been some note made of the faulty attitudes causing round shoulders, with some mention of shoulder-straps and braces for the correction of the deformity. Among both German and English writers in dealing with this subject there has been some discussion as to what the normal attitude should be, and to what extent certain deviations can be considered as abnormal. The difficulty experienced in classifying the degrees of deformity from faulty attitude has been that the deviation of the spine alone has been considered, whereas the relative position of the legs, pelvis, and feet should also be considered. Any accurate adjustment of the body to maintain the equilibrium must necessarily include the pelvis and lower extremities. In studying the subject of round shoulders and faulty attitude it is important to take into consideration just what the normal attitude actually is, and how the deviation from the normal is produced, and in what manner this deviation can best be corrected.

In making a study of the normal attitudes Lovett has collected statistics showing that, in measurements taken of 72 college boys and 100 college girls, the variations among the girls were much greater, the general tendency being to carry the body further forward and to hyperextend the knees, the lumbar curve being more pronounced in the boys. Of the faulty attitudes assumed by the average individual there are four types of curve resulting: an exaggerated general curve from the mastoid backward to the fourth lumbar, a backward projection, chiefly in the mid-dorsal region, a curve in which the head projects forward from the seventh cervical while the lower spine remains straight, and a deformity where the spinal points are almost in a straight line and the back nearly flat. This classification corresponds very closely with that of Staffell, in his "round back," "round hollow back," "hollow back," and "flat back."

In treating round shoulders too much dependence should not be placed upon the use of apparatus, but the English military brace made of jean has

been found to act as a very valuable reminder. In my experience the most useful form of treatment has been appropriate gymnastic exercises; and of these, I have found the exercises similar to the "setting-up" drill of the cadet to be of the greatest value. Exercises bringing the abdominal, gluteal, and hamstring muscles into play are of service, and the raising of heavy weights has been found of benefit in exercising the muscles which maintain the body in the normal standing position. All the exercises should aim to improve the general balance of the body as well as to correct the deviation of the spinal column, and the patient should also take a certain amount of rest each day to enforce the benefit from the gymnastic exercises.

Among the most useful exercises for the correction of this condition is one taken with the patient lying upon the table in the supine position with the arms at the sides and the palms turned upward. The arms are brought forward to a right angle with the chest, the hands are turned over, and the arms are then carried upward into the fully extended position, and are then swept outward and downward to the first position.

Another useful exercise is taken with the patient in the supine position, and with the arms at the sides, a one-pound dumb-bell is grasped in each hand. The dumb-bells are then brought outward and upward with the arms fully extended, the palms of the hands facing downward, until the arms are above the head, and from this position they are carried forward in the fully extended position until they are at a right angle with the body, and are then slowly brought downward to the first position.

In taking these exercises in the supine position it is best to have the knees bent so that the lumbar region rests upon the table.

Muscular Kyphosis.—Kyphosis may result from muscular weakness induced by faulty attitudes due to occupation. This form is met in tailors, cobblers, carpenters, and among laborers. It is at first purely muscular from faulty attitude and over-development of certain muscles, and it eventually becomes permanent from changes in the bone.

The severe kyphosis met in old age is usually the result of tissue metamorphosis, absorption occurring in the intervertebral discs, the curve becoming permanent.

The kyphosis which results from spinal meningitis should be considered here. Associated with the deformity of the lower extremities,—spastic contracture of the limbs with talipes valgus from contraction of the extensor longus digitorum,—we have a long posterior curve in the spine with rigidity

and without pain. In the treatment of this affection the writer has found it best to discard spinal appliances and to depend upon the use of gymnastic exercises. Apparatus worn upon the limbs should be as light as possible and should not extend any higher than is absolutely necessary.

Rachitic Kyphosis.—The kyphosis met in rickets is most marked in the lumbar region and may be associated with lateral curvature. There are always associated with it the characteristic changes in other parts of the body, the open fontanel, rachitic rosary, enlarged abdomen, pendulous abdomen, enlarged epiphysis, and frequently deformity of the long bones. The deformity in rachitic kyphosis disappears in recumbency and in suspension.

Chondrodystrophia.—In fetal rickets, or chondrodystrophia, the deformity of the spine is similar to that met in infantile rickets, but the early ossification of the epiphysis of the extremities produces an appearance which cannot be confounded with the latter disease. Moreover, it has usually associated with it a deformity of the chest. The kyphosis is more rigid than in infantile rickets, but there is not the spasmodic contraction which is present in Pott's disease.

Osteitis and Spondylitis Deformans.—The kyphosis occurring in these affections will be considered in its proper place.

Scorbutic Spondylitis.—The occurrence of kyphosis in infantile scorbutus is extremely rare, but its possibility should not be overlooked. There are usually associated with it other joint lesions resembling rheumatism, the joints being enlarged, red, and hot. The swollen blue gums and the purpuritic ecchymoses beneath the skin and mucous membranes should render the diagnosis easy, but if the epiphysis becomes separated by ulceration the affection may easily be mistaken for acute epiphysitis of infancy or for malignant disease. The treatment should consist in the fixation of the spine, with improved diet, especially the use of peptone preparations, and orange juice.

Typhoid Spine.—The secondary infection of the periosteum and bone which follows typhoid fever has been described as typhoid spine by Gibney, although the disease was previously noted by Maisonneuve in 1835. It is characterized by a stiffness, localized pain, and weakness of the spine occurring during convalescence from typhoid fever. A slight kyphosis usually occurs and the pathologic process has been found to be either a simple periosteitis, a periosteitis with subperiosteal abscess, or periosteitis with osteitis. The pathologic changes in the spine do not differ from those which are met

elsewhere as sequels of typhoid fever. The spine should be fixed with a plaster cast, and recovery is the rule.

Syphilis of the Spine.—This rare condition of the spine occurs in three forms—infantile hereditary, hereditary, and acquired. It is much less common than Pott's disease, because, according to Fournier, 77 per cent. of these children are still-born, and it is a well-known fact that many of them die during the first years of infancy. The affection resembles Pott's disease in the kyphosis, but there are manifestations of the general disease, there is an absence of tubercular symptoms, and the pain resembles more closely that in sarcoma, being of a local character rather than radiating to the anterior region, as in Pott's disease. Muscular rigidity is marked.



FIG. 280.—TRAUMATIC SPONDYLITIS WITH PSOAS ABSCESS.

Traumatic Spondylitis.—This is quite a common affection among the laboring classes, the most frequent lesion being a rupture of the muscular fibers of the psoas and iliacus. The deformity is usually slight, and the affection is frequently mistaken for abscess of the liver, pancreas, kidney, and other viscera. The history of an injury followed soon by a lumbar abscess is the most important diagnostic sign of the affection. Traumatic spondylitis is occasionally followed by caries sicca, either involv-

ing a large number of vertebrae and giving a long curved kyphosis, or involving only a few vertebrae and producing a localized kyphosis. Injuries to the ligaments give rise to the symptoms of "railway spine." The hypersensitive con-

dition of the skin and muscles, excessive spasm upon flexion, and atrophy of the erector spinæ muscles render the diagnosis easy.

It is more difficult to make a correct diagnosis when the injury occurs in children and when there is no medico-legal complication. In treating this affection the abscess should be evacuated by an incision above Poupart's ligament and counter-drainage should be established in the lumbar region. It is essential that the spine be fixed with a plaster cast, and the treatment should be conducted in the same manner as has been described in lumbar abscess due to Pott's disease.

Infectious Diseases of the Spine.—Infectious diseases of the spine due to (1) osteomyelitis, (2) actinomycosis, and (3) gonorrhea usually produce a kyphosis.

In acute osteomyelitis pus formation occurs early. Large sequestra form and the course is rapid. The majority of these cases occur during adolescence, from overwork and trauma, and the lumbar spine is the most frequently affected. It is frequently mistaken for typhoid, peritonitis, pleurisy, or pneumonia. Rigidity with spasm and local pain is constant, but deformity is present in less than 10 per cent. of the cases. Subsequently there is deep fluctuation with venous stasis of the local veins and edema. In the 56 cases analyzed by Grisel the body was affected in 19, the posterior arc in 21, and the whole vertebra in 3. Of 53 cases carefully reported, 30 died and 23 recovered. Bacteriologic examination shows *Staphylococcus aureus* to be the most frequent cause. As soon as deep fluctuation can be detected, the abscess should be incised and drained. The fistulas are not persistent.

In actinomycosis the separation of the anterior ligament from the bodies of the vertebrae is produced by the formation of pus. The surface presents a worm-eaten appearance and the disease is of such extreme rarity that a positive diagnosis cannot be made from the physical signs, but a microscopic examination of the pus taken from the sinuses would establish a correct diagnosis.

The spine is not so frequently the subject of gonorrheal infection as many of the joints, but the diagnosis can be determined from the history of sudden onset and the association of other joint lesions. It resembles Pott's disease, but is more painful during the early stage.

Acromegaly.—The kyphosis in acromegaly is sometimes enormous, being due, as pointed out by Osborne, to an absorption of the intervertebral

discs. The vertebrae are sometimes co-ossified and exostoses mark the position of the intervertebral discs.

Hypertrophic Pulmonary Osteoarthropathy.—Kyphosis is sometimes present in hypertrophic pulmonary osteoarthropathy, as pointed out by Marie. The enlargement of the articular extremities of the bones, the incurvation of the nails, the bulbous swelling of the terminal phalanges, and the enlargement of the lower jaw, with the association of the disease of the lungs and pleura, would render the diagnosis clear.

Malignant Disease of the Spine.—The new-growths met in the spine



FIG. 281.—PRIMARY SARCOMA OF SPINE, SHOWING DEFORMITY.

are sarcoma and carcinoma, both of which are commonly secondary. Primary carcinoma of the spine may be considered a pathologic curiosity, and primary sarcoma is sufficiently rare to deserve special consideration. Sarcoma is met in three forms—lymphosarcoma, spindle-celled sarcoma, and round-celled sarcoma. Charcot confirmed the observations of his predecessor, Cazalis, at the Salpêtrière as to the prevalence of secondary deposits in the lumbar region in patients who have died of cancer of the breast, both in men and women (Terrier), giving it the name of paraplegia dolorosa. In car-

cinoma the pain is lancinating, anesthesia is absent, and hyperesthesia is frequently present. Paralysis of the bladder and rectum are late or absent, and bedsores are apt to form. The writer has observed several cases of secondary sarcoma and has reported one case of primary sarcoma.

Sarcoma of the Spine.—In this condition the affected region of the spine projects backward in two round masses on either side of the median line. Subsequently these increase in size, the pain increases in the lumbar region, and peripheral neural pain in the thighs continues, and the super-

ficial veins of the abdomen become greatly enlarged and the abdomen greatly distended. The emaciation is extreme. Distinct dullness occurs in the epigastric and left hypochondriac regions, and the circulation in the superficial veins of the abdomen becomes reversed, acting as a collateral circulation to the obstructed deep circulation.

Symptoms: The characteristic symptoms are pain, paraplegia, grave constitutional involvement, rapid course, and metastasis. Incontinence of urine and feces occurs early and is persistent. Amidon has reported metastasis of all the organs and tissues; the liver, kidneys, lungs, and muscles of the back being most frequently affected. In my case the metastatic growths in the postorbital region were peculiar, but there were probably growths in the liver and in all the organs of the abdomen. According to Edes, the pain in sarcoma of the spine is not nearly so severe as in carcinoma, whether it be primary or secondary. It is increased on pressure, on standing, upon sitting up quickly, or upon turning over in bed.

Diagnosis: The diagnosis may be made from the severe localized pain, the paraplegia (*paraplegia dolorosa*), the tenderness over the spine, the deformity being rounded, less acute, and containing no bursa, the rapid pro-

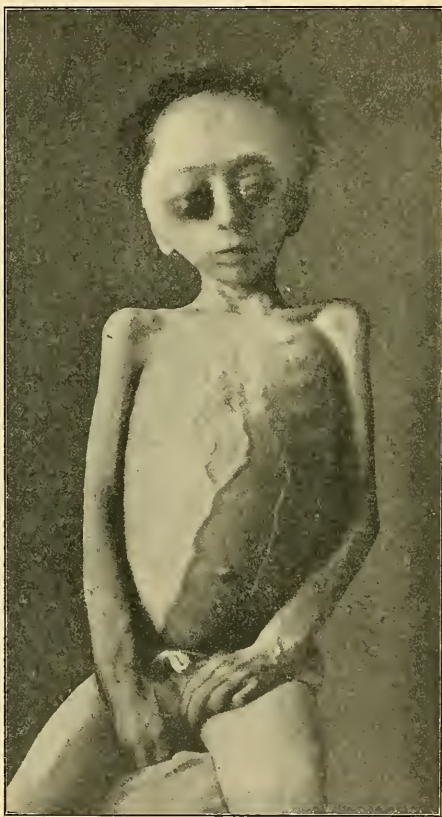


FIG. 282.—SARCOMA OF SPINE SHOWING VENOUS STASIS AND METASTATIC GROWTH IN ORBIT.

gress of the disease and the seriousness of the affection from the very earliest stages to the fatal termination.

Differential Diagnosis: Primary sarcoma of the spine may be confounded with a number of affections, including the following: Pott's disease, caries sicca, rickets of the spine, neuromimesis, sacro-iliac disease, peri-

nephritic and appendicial abscesses, syphilis of the spine, typhoid spine, senile kyphosis, osteoarthritis, iliac abscesses, severe lateral curvature, hip-joint disease, lumbago, sciatica, spinal irritation, spinal meningitis and pachymeningitis, intraspinal growths, posterior spinal sclerosis, aneurysm, compression myelitis, and spina bifida.



FIG. 283.—AGGRAVATED TYPE OF LATERAL CURVATURE RESEMBLING SARCOMA OF SPINE.

1. **Pott's Disease:** The most frequent disease with which sarcoma of the spine is confused is Pott's disease of the spine. The two most common symptoms of sarcoma of the spine, pain and paraplegia, are present also in Pott's disease, but the personal observation of the writer leads to the belief that there is a difference in both these symptoms. The pain in sar-

coma is located in the region of the deformity or may be radiated to the thighs. In Pott's disease there is seldom pain in the lumbar region and peripheral pain is always most marked. Paraplegia is present in sarcoma very early, is associated with incontinence of urine and feces, and is persistent. In Pott's disease paraplegia comes on gradually. When the paraplegia is advanced and due to compression myelitis, the symptoms are much the same in both. Muscular spasm, due to the irritation of the psoas muscles and the erector spinæ mus-

cles, occurs in both. The attitude is much the same in both, the body being flexed and the lower extremities contracted. The local pain and tenderness are present in sarcoma, but are absent, or very seldom present, in Pott's disease. The deformity in sarcoma is rounded, less acute, and the projection of the vertebrae does not have a bursa upon it, as pointed out by Tubby. In Pott's disease the deformity is medium, angular, and permanent except in the rare instances in which there is lateral deviation of the spinous processes from unilateral spasm. In sarcoma of the spine suppuration does not occur, whereas in Pott's disease abscesses occur frequently. The general system suffers quickly in sarcoma, emaciation, edema, and cachexia being constant symptoms; whereas in Pott's disease the emaciation is a late symptom from profuse suppuration, cachexia if present is a very late symptom, and edema if it occurs is due to anemia or renal disease, and not to obstruction.

The following table will render the diagnosis clearer:

POTT'S DISEASE.		PRIMARY SARCOMA OF SPINE.
1. Antecedents,.....	Tuberculous.	Malignant.
2. Duration, ...	Slow.	Rapid.
3. Malaise, ...	General malaise early. Cachexia late from kidneys.	Cachexia early.
4. Pain, ...	Peripheral. Absence of local tenderness.	Local tenderness present.
5. Deformity, ...	Present and angular.	Absent or rounded, without bursa.
6. Abscesses, ...	Present.	Absent.
7. Paraplegia, ...	Late and Partial.	Early and complete.
8. Emaciation and anemia, ...	Occurs late.	Occurs early.
9. Cachexia, ...	Absent or late.	Early and persistent.
10. Edema, ...	Rare. Renal.	Common. Obstructive.
11. Temperature, ...	Hectic.	Apyretic.
12. Location, ...	Most frequent in dorsal region.	Most frequent in lumbar region.
13. Infection, ...	General to nervous system or lungs.	Metastasis to all organs, especially the liver.

2. Caries Sicca: The flexion of the spine, the disability, the pain, in caries sicca associated with a history of traumatism, would in some cases lead to an incorrect diagnosis, but the long curve which is always present, its angularity, the absence of local tenderness and peripheral pain, and in some cases the association of osteoarthritis in other joints (rhizomelic spondylosis) would lead to a correct diagnosis.

3. Rickets of the Spine: The deformity in the lumbar region together

with the pseudoparaplegia (of Perrott) might be confusing, since sarcoma occurs in children as well as in adults. The presence of rachitic conditions in other parts of the body, the open fontanels, the enlarged epiphyses, the rachitic rosary, and the protruding abdomen would quickly decide the question.

4. Neuromimesis: A careful clinician should not be misled by the varied manifestations of hysteria. A correct diagnosis may usually be made



FIG. 284.—TRAUMATIC SPINE. CARIES SICCA.

by observing the presence of an inherited or acquired neurotic diathesis, the simultaneous appearance of pain and deformity, the correspondence of the hyperesthetic and paresthetic areas to the distribution of the nerve-branches, instead of the unmistakable signs of organic disease met in sarcoma.

5. Sacro-iliac Disease: Sacro-iliac disease resembles sarcoma in the deformity, in the local tenderness, and in the disability, but the location of the deformity and the sensitiveness are different. There is no psoas irritation and the body in the characteristic attitude

("position hanché" of Hattute) is inclined to the opposite side and not forward. Moreover, there is frequently a history of tuberculosis, inherited or acquired, and an absence of cachexia, except in the very advanced stages of the disease. Abscesses are frequent in sacro-iliac disease.

6. Perinephritic and Appendicial Abscesses: Both these diseases have one symptom in common with sarcoma, psoas irritation and contraction of one or both thighs. In the absence of abscess a diagnosis may be made by careful differentiation of the symptoms of these two affections from those

which are met in sarcoma. In the absence of urinary symptoms the presence of pain, edema, and tenderness upon pressure over the region of the kidney, with nausea and vomiting, and the absence of the cardinal symptoms of sarcoma will differentiate perinephritic disease. The rapid onset of epigastric or umbilical pain with vomiting, the presence of acute localized tenderness with unilateral rigidity of the abdominal walls, intestinal disturbances with rapid pulse and moderate temperature, will serve to distinguish appendicitis from primary sarcoma.

7. Syphilis of the Spine: This rare condition of the spine, whether primary or secondary, resembles sarcoma in the deformity and in the local tenderness, but it is more common in adults, and affects the upper part of the column more frequently than the lower; moreover, the history of acquired or congenital specific disease, the presence of lesions in other parts of the body, and the long continuance of the affection, together with the absence of the characteristic symptoms of malignant disease, would lead to a correct opinion. This condition has been observed by the writer in an infant.

8. Typhoid Spine: In typical cases the resemblance of the spondylitis which occurs after typhoid fever to sarcoma is apparent in the tenderness upon pressure, the severe pain, and the increase in temperature; but the history of the case, the absence of deformity, and the disappearance of the affection under appropriate treatment would serve to distinguish it from sarcoma.

9. Senile Kyphosis: The severe kyphosis which sometimes accompanies old age resembles sarcoma in the deformity, but the curve is more frequently in the dorsal region and there is an absence of the acute symptoms, the cachexia, and the more serious symptoms which are characteristic of the latter disease.

10. Osteoarthritis: The occurrence of osteoarthritis in the spine shows a resemblance to sarcoma in the rigidity, the contraction of the lower limbs, and the obliteration of the normal lordosis, but the history of traumatism, the association of the disease with lesions of the other joints (hip and shoulder), the absence of a marked kyphosis in the lumbar region, and the absence of the grave symptoms of malignant disease will be sufficient to prevent confusion.

11. Iliac Abscesses: The large collections of pus in the iliac fossa from tuberculosis of the spine and other causes sometimes resemble malignant disease of the spine, particularly when they occur in adults. The history of traumatism, the unilateral character of the affection, the presence

of fluctuation with a mass in the iliac region, and the absence of the cardinal symptoms of malignant disease will distinguish this lesion.

12. Severe Lateral Curvature: In severe primary lumbar lateral curvature where deformity and pain are prominent symptoms the resemblance to sarcoma is sometimes very striking. This is particularly true in adults, as in a case under the writer's observation in a single woman aged fifty-six years, who had fallen eight years before, and who presented a great deformity of the lumbar region, with excruciating pain in this region, radiating to the thighs. The history of the attack, the long period of the disease, the presence of compensatory curves, the absence of cachexia, and the general health of the individual would lead to a correct diagnosis. Moreover, the deformity is *always* unilateral.

13. Hip-Joint Disease: The resemblance between hip-joint disease and the lesions of the lumbar region, whether tubercular or otherwise, is oftentimes very striking. Psoas irritation is present in hip-joint disease and also in sarcoma, but the history of a tuberculous diathesis, of traumatism, the location of the pain in the knee, the fixation of the joint, with the characteristic deformities of the different stages, the changes in the gluteofemoral fold, with the swelling, induration and pain, particularly in the trochanter, with the formation of abscesses, would render the diagnosis distinct from that of malignant disease.

14. Lumbago: The resemblance between severe lumbago and malignant disease of the spine is very characteristic, and a severe lumbago resisting treatment and continuing for a long period should excite suspicion of malignant disease. The evanescent character of the affection and the rapid amelioration under proper treatment, together with the absence of symptoms characterizing malignant disease, should render the diagnosis of ordinary lumbago simple.

15. Sciatica: The pains in the sciatic region occurring in sarcoma of the spine resemble sciatica so closely that the occurrence of double sciatica without other history, especially of diabetes, should lead to a very careful examination for sarcoma of the spine. The pain is more severe in cases of carcinoma of the spine. Painful paraplegia from sarcoma of the spine has been reported by Kemper.

16. Spinal Irritation: The symptoms in spinal irritation resemble those met in sarcoma, but in the former affection the spinal tenderness is more exquisite and general and the pains are non-neural, evanescent, and fugitive.

Spinal irritation is more frequent in females and the history of the patient would assist in arriving at a correct diagnosis.

17. Spinal Meningitis and Pachymeningitis: The symptoms in these affections are characteristic of themselves, but as there is some similarity to those of sarcoma, it is necessary to call attention to the possibility of confusing the two. These diseases and sarcoma are equally rare, but the former are characterized by non-neural pains and various spasmodic conditions, which are pathognomonic.

18. Intraspinal Growths: Intraspinal growths of a benign nature produce symptoms resembling sarcoma. In fact, when the secondary lesions of sarcoma invade the spinal canal a differential diagnosis would be impossible. Peripheral pain without paraplegia and the early appearance of paraplegic symptoms with a marked deformity, localized tenderness, and characteristic signs of a serious malignant type of disease would suggest the possibility of an intraspinal growth. The vasomotor disturbances, in the experience of the writer, are quite characteristic of a benign growth in the spinal canal.

19. Posterior Spinal Sclerosis: The classic symptoms of locomotor ataxia are so characteristic that it could not readily be confused with malignant vertebral diseases. Moreover, the presence of ataxia, the diminution of reflexes, impaired sensations, the absence of all pain, the pupillary changes (Argyll-Robertson pupil), and incoordination would serve to distinguish locomotor ataxia from malignant spinal disease.

20. Aneurysm: Aneurysm of the abdominal aorta eroding the vertebral bodies produces symptoms which resemble sarcoma, especially in the length of the curve and the localized pain. This affection occurs late in life, and in addition to these symptoms there are added the characteristic symptoms of aneurysm which would render the diagnosis clear.

21. Compression Myelitis: This disease resembles sarcoma of the spine in the lumbar region very closely, especially in the early supervention of paralysis with vesical and rectal disturbances; but the absence of acute pain and the presence of the pressure symptoms, together with the history of the patient, would lead to an early recognition of this affection.

22. Spina Bifida: The resemblance between lumbosacral spina bifida and sarcoma in this region has been pointed out, but the fluctuation and translucency, and especially the arborescent zone of vascularization, will aid in differentiation. Moreover, spina bifida is congenital.

Prognosis: In the present state of medical knowledge there is but one, a fatal prognosis, in these cases.

LORDOSIS.

Lordosis is a deformity characterized by an anterior curvature of a part or the whole of the vertebral column.

Synonyms.—*German*, Vorverbiegung der Wirbelsaule; Lordotische skoliose. *French*, Lordose. *English*, Spinal Incurvation or Anterior Deformity.

It may occur in any part of the spine, but is most common in the lumbar region. It is characteristic of some races, as the Terra del Fuegians and Cubans. It is present in professional contortionists, and in those whose occupations compel them to carry heavy weights upon their heads, and in tailors from acquired contraction of the iliopsoas muscle. It may be classified under three heads—compensatory, paralytic, and pathologic.

Compensatory.—It occurs as a compensatory symptom in kyphosis of the dorsal region from an effort to establish the equilibrium of the spine, in pregnancy either as a temporary or permanent condition, from the abdominal enlargement in rickets, or from tumors. It is seen in congenital dislocation of the hip from the posterior position of the head of the bone. It is also a symptom in contraction of the spinal muscles.

Paralytic.—The paralytic form of lordosis is present in progressive muscular atrophy, in pseudo-muscular palsy, and in paralysis of the abdominal muscles of the pelvic extensors.

Pathologic.—The pathologic form is encountered in hip disease, either single or double, from contraction or ankylosis. It is present in contraction of the hip from infantile palsy, and may be observed in the early stage of lumbar Pott's disease. It is a marked symptom in spondylolisthesis, which affection constitutes so important a deformity that it will be considered separately.

The different varieties of lordosis require appropriate treatment according to the severity of the deformity, the treatment consisting in the use of electricity, massage, the application of spinal appliances, and the correction of the deformity which has produced the compensatory change. The spinal appliances consist of a firm pelvic band with elastic, tempered, spinal up-rights, to which are attached axillary bands, and an abdominal apron, or an abdominal and thoracic band.

SPONDYLOLISTHESIS.

The spondylolisthetic pelvis was first described by Rokitsanski, who reported two cases in 1839, and the name spondylolisthetic (from *σπόνδυλος*, "a vertebra," and *ἐκπίσθησις*, "a slipping down or out") was given it by Kilian in 1853, who gave the first accurate description. The knowledge of the condition is, however, mainly due to Neugebauer, who collected over ninety cases and specimens, and its etiology has been greatly cleared up by the discoveries of Lane. The condition is more common in females, Schlesier, up to 1892, having collected fifty-three cases in skeletons, only three of which were male. This may be due largely to the sexual differences in the inclination of the pelvis. The condition is uncommon.

Spondylolisthesis may occur in other vertebrae, but is most common in the lumbosacral articulation. The name is descriptive of the condition, which is produced mainly by two factors: (1) a malformation, and (2) strain or violence. Because of its embryonal origin being from different centers it occasionally occurs that the bony development of the last lumbar vertebra is imperfect from non-union of its component parts. In other words, between the upper and lower articular processes the bony ring is sometimes cartilaginous or composed of fibrous tissue. While spondylolisthesis is rare, this defect in ossification (called *spondylolysis articularis*) is common, although by itself being insufficient to cause the deformity. In considering the second factor, strain or violence, we find that if a patient with this malformation has had to do very heavy labor, or is exceedingly obese, or if by violence the spinal column is suddenly driven down, a fracture may occur at the line of imperfect union with a dislocation forward of the vertebral body and upper articular processes. This deformity will arise gradually if from strain, and suddenly if from violence. In some cases the patient gives a history of a long preceding illness during the development of the deformity, but this may be coincidental. While it is claimed that spondylolisthesis may arise without any defect in ossification—one or two cases having been reported—there would necessarily be either a dislocation anteriorly of the last lumbar vertebra with the sacral articular processes after fracture of these processes, or fracture of the articulating portion of a normal last lumbar vertebra; both occurrences being theoretic.

Secondary Changes.—When the deformity has occurred the mechanical conditions of the bones are altered and, according to Wolff's law, the structure is greatly changed. The changes occur as follow: (1) The canal

of the last lumbar vertebra is enlarged from before backward. (2) The body of the vertebra is not supported in front in its new position and sinks down, its anterior portion forming an angle, opening downward, with its posterior portion. (3) Between the weight of the bony column above and the pressure of the sacrum below, the body is compressed behind and becomes bluntly wedge-shaped, the base of the wedge being anterior. (4) The slipping forward of the last lumbar vertebra throws an unusual strain upon the intervertebral substance between it and the sacrum, and the result of this strain is the growth of bony substance in the intervertebral tissue, and in the angle between the displaced lumbar vertebra and the first sacral vertebra. This last change is really conservative in character, as it prevents further dislocation. (5) Because of the different disposition of the body-weight there is also a backward dislocation of the sacrum and a flattening of the sacral canal.

There are four stages of the deformity, according to the degree: (1) When it projects, (2) when it hangs over toward the pelvic brim, (3) when it has sunk into the pelvic brim, and (4) when it has sunk into the pelvic cavity.

The defect in ossification may be present only on one side, in which case the last lumbar vertebra will slip forward on this side the more easily, producing an asymmetric deformity. The disease is, however, so rare that it is unnecessary to describe the various modifications in particular specimens due to the degree in the advance of the morbid changes.

On account of the pelvic changes in spondylolisthesis and their diagnosis there are three important points to be considered: (1) There will usually be a history of some violence or strain resulting in a protracted illness severe enough to render confinement to bed necessary, and attended with pain in the lower part of the back. This injury usually occurs during the age of the development of the pelvis—from the fifteenth to the eighteenth year. (2) There is a marked bodily deformity, there being a shortening of the body in the lumbar region. In severe cases the ribs are sunk into the false pelvis, and in less severe cases approximate the iliac crests. This renders conspicuous the great breadth between the wings of the ilia, especially viewed posteriorly. (3) Lordosis is markedly present and the anterior edges of the bodies of the lumbar vertebrae are widely separated while the posterior portions, the articular processes and neural arches, are pressed together, which pressure may cause the development of osteomata, ossifica-

tion of the ligaments, and possibly synostosis. The back of the sacrum is plainly felt, and the posterior superior iliac spines are further apart than ordinarily because of the backward pressure of the sacrum and the separation of the ilia. The genitals look further forward than under normal conditions because of the lessening of the inclination of the pelvis. The abdomen is creased above the symphysis, the flanks are fuller, and the buttocks assume a very peculiar heart-shape, tapering together and ending in a point below, and they are also flattened. The gait is peculiar, the patient walking with short steps, and the feet slightly inverted, so that the foot-marks are deficient in breadth. The legs turn inward, and as the patient walks are placed one in front of the other.

The promontory in the spondylolisthetic pelvis is not a sharp angle because of the new osseous growth, but upon digital examination the alæ of the sacrum are distinctly felt, and the abdominal aorta with its bifurcations may also be felt, and sometimes the lower borders of the kidneys may be detected upon palpation.

The presence of spondylolisthesis seriously interferes with delivery in labor, since even if the measurements be only slightly lessened malpresentations are not uncommon, and fistulas and lacerations not infrequent. A large proportion die in labor.

DEFORMITIES OF THE THORAX.

Deformities of the chest are either congenital or acquired, and are of three principal types—funnel chest, flat chest, and pigeon breast. The congenital are chiefly due to fissure and defects, and the acquired generally result from pathologic conditions, notably from rickets.

Congenital.

Congenital deformities of the chest are very rare and are usually found in monstrosities or in persons suffering from a complication of deformities. The deformities arising from congenital causes are of different varieties. The sternum may be entirely absent or only partially so, and frequently it is fissured about the median line, the ribs being attached to either side of the fissure, which is sometimes subdivided transversely by bands of tissue, and there is often a separation of the sternum, triangular in shape, with the base upward, during respiration. There may exist a hernia of the lung through the fissure. In the partial or total absence of the sternum it may be replaced by a fibrous

structure to which the ribs are sometimes attached, while at other times they may be free. There may be only a partial development of the sternum, in which case the ribs on the affected side are free and the intervening space is

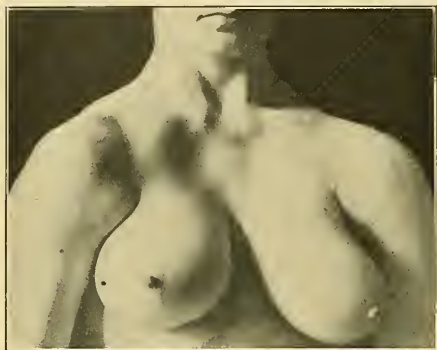


FIG. 285.—FUNNEL CHEST. FRONT VIEW (Richards).

filled in by membrane which bulges during expiration and retracts during inspiration. Pulsation of the heart and aorta may be noted through this membrane. There may also be perforation of a section of the sternum.

There may exist an absence of one or more vertebrae, which is usually associated with rachischisis, but it may be present with no other symptom than a noticeable shortening of the spine,

and is usually associated with some defective formation of the corresponding muscles. The pectoral muscles—pectoralis major, pectoralis minor, intercostals, and serratus major—may be absent or defective, which will cause deformity but appears to give rise to no direct symptoms, and is probably the result of some mechanical interference. This congenital defect of the muscles is usually unilateral in character, whereas the acquired form is, as a rule, bilateral. The defect in the muscles is frequently discovered only by accident, since it causes the patient little or no inconvenience, the principal symptom being that of fatigue.



FIG. 286.—FUNNEL CHEST. SIDE VIEW (Richards).

Deformity may sometimes be produced by absence of the clavicle, as

referred to in the chapter upon Non-tuberculous Diseases of the Shoulder. In some instances it may result from the absence of one or more ribs, the intervening space being filled with membrane; or there may be an increase over the normal number of ribs. As the increase is usually an additional cervical rib or pair of ribs, the chest is increased in length.

Funnel Chest.—Synonyms: *pectus excavatum*, *Trichterbrust*. This variety of deformity of the chest is almost without exception congenital, but in very rare instances it may be associated with Pott's disease or with rickets. It is sometimes a hereditary condition, and has been described particularly by Ebstein and Klemperer. It is due, according to Zuckerkandl and Ribbert, to the pressure of the inferior maxillary bone upon the inferior segment of the sternum during fetal life. Ebstein attributes the deformity to an arrest of development of the sternum. It might be due to dystrophy of the muscles of the back and scapulas, which was the cause in the case illustrated.

It is characterized by a depression of the entire sternum, the costal cartilages forming the lateral borders of the infundibulum, while the abdominal wall forms the inferior border. The extensive depression of the sternum has the effect of increasing the transverse diameter of the chest, but otherwise has no influence upon the direction of the spinal column.

Acquired.

The acquired varieties of deformity of the thorax are generally due to rickets, but may result from obstruction to respiration or from mechanical conditions, or it may result from avocation.

Flat Chest.—This deformity is characteristic of certain professions, such as shoemakers, lace and embroidery makers, etc., and consists of a sinking in of one side of the chest at the level of the xiphoid process. It is frequently associated with round shoulders, the flat appearance of the chest being partially due to the displacement forward of the shoulders and scapulas. Where not the result of avocation, it is simply an exaggeration of the normal flat chest through round shoulders or kyphosis.

Pigeon Breast.—Synonyms: *Huhnerbrust*, *Kahnbrust*, *pectus carinatum*, *poitrine en carène*, *poitrine de pigeon*. This deformity is characterized by the projection of the sternum and cartilages in the form of a keel, or similar in shape to the breast of a bird, the lateral compression being most pronounced at the junction of the ribs and cartilages. The transverse diameter is enlarged and the lateral diameter is diminished. There may be a second depression

occurring in the mid-axillary region, and by reason of the strain upon the diaphragm there sometimes occurs a third depression, oblique in character, at about the level of the ensiform cartilage. The capacity of the chest and respiratory organs is greatly diminished, especially when the deformity is associated with Pott's disease, and there is pronounced dyspnea, with palpitation of the heart. This symptom is also characteristic of the deformity when associated with scoliosis.

As a general rule, this deformity is due to rickets, but it may result from Pott's disease, and also from paralytic conditions. Where it is the result of rickets, the sternal bone projects the entire length of the chest, increasing the effect of the "rachitic rosary." The entire thorax bends upon pressure. Posteriorly the ribs do not change their direction, but at about 12 or 15 cm. from their attachment they curve suddenly and form an internal angle at this point. The depression in the mid-axillary region ceases at about the ninth or tenth rib, where an enlargement of the thoracic walls occurs in order to accommodate the distended abdomen. This enlargement may continue after the distention of the abdomen has disappeared. Deformities of rachitic origin are due to inequalities of external and internal pressure and to the action of the diaphragm and the muscles of respiration acting upon the flexible and malleable bones. External pressure is an important agent and, according to Redard, it is noticeable that when children preserve the dorsal decubitus the anteroposterior diameter decreases and the curve of the ribs increases, whereas if the dorsal decubitus is lateral the antero-posterior diameter is augmented while the curve of the ribs is diminished. The deformity may vary according to whether the patient lies habitually on the right or left side.

Deformities of the chest resulting from Pott's disease have already been mentioned under that head.

Thoracic deformity is a frequent result of obstruction of the respiratory passages. Chance, in 600 rachitic cases found 156 instances of deformity resulting from nasal or post-nasal obstruction, spasm of the larynx, and nasal polypi. This variety of deformity consists in an arching and narrowing of the chest at the lower portion, and an excavation of the sides, showing at about the center of the arch two transverse furrows caused by the depression of the middle section of the ribs. The antero-posterior diameter increases while the transverse diameter decreases, especially at the base. In some instances the entire thorax seems to have undergone an arrest of growth, and the contrast to the development of the neighboring regions is striking.

This variety of deformity is present in infancy when there exists respiratory obstruction, and it is liable later to be followed by kyphosis and scoliosis, during the principal period of growth, up to the sixteenth year, as a consequence of chronic inflammations and affections of the nasopharyngeal organs, so frequently present at this period. According to my experience, adenoid tumors by causing nasal obstruction are an almost invariable cause of deformity of the chest. Hypertrophy of the tonsils, to which Dupuytren, Cooper, Forster, Coulson, and Warren have attributed thoracic deformity, plays an unimportant part, at least in so far as it is seldom accompanied by adenoid growths. Nasal hypertrophy with chronic atrophic rhinitis, enlarged tonsils, deviation with hypertrophy of the wall of the septum, and the osseous sinking of the posterior orifice of the nasal fossas, may also be complicated by changes in the form of the chest. In consequence of the nasal obstruction and of insufficient respiratory action, with imperfect development of the chest during respiratory movements, the chest cannot dilate properly, and deformity results.

According to Redard, deformities of the chest and of the spine which result from nasal obstruction present none of the general characteristics of rickets, but the nasal obstruction sometimes met with in rachitic subjects may play some part in the thoracic deformity common to this affection, the ribs and sternum, by reason of their flexibility and malleability, offering favorable conditions to the development of deformity as a result of these chronic affections. In very young children showing multiple rachitic lesions these deformities are produced rapidly and at a very early age, which would differentiate them from thoracic deformities due to obstruction of the respiratory passages, which develop slowly and are usually found in adolescence.

Deformities of the chest have been known to follow spasm of the glottis and the paralytic conditions resulting from whooping-cough. They may also follow chronic affections of the pleura and hypertrophy of the heart, and are characterized by the projection or depression of the chest according to the period of the disease. Deformities following pleurisy, especially those following pleuropneumonia or empyema (sunken chest of Laennec), often produce complex results from the retraction of the pleura and lung, from insufficient respiration, from the immobilization of one of the sides of the chest, from neuritis, and from atrophy of the neighboring muscles. The thoracic deformity in these cases is frequently the cause of a resultant spinal deviation.

Deformity sometimes results from paralysis or atrophy of the muscles of the chest. In progressive muscular atrophy in infancy, or in adults, the

anterior thoracic wall becomes flattened and sometimes concave, the antero-posterior diameter is diminished, and the sternum forms a sort of furrow, the costal cartilages forming the lateral walls.

Prognosis.—The prognosis in deformity of the chest varies according to the cause and extent of the deformity, and, as a rule, is favorable only when the treatment is undertaken at a very early stage of the affection. Certain varieties have a very deleterious effect upon the heart and lungs, and the contraction of the diaphragm, and consequent insufficient respiration, has a very injurious effect upon the general health.

Treatment.—The treatment should consist chiefly in removing the primary cause of the deformity. In cases of rachitic origin it should be the same as for rickets, and in those resulting from nasal obstruction the respiratory organs should first be carefully treated.

Funnel chest is not very amenable to treatment, but improvement may be derived from care as to hygiene, exercise, and diet. Phosphorus, 1 : 100 to 1 : 150 t. i. d., is beneficial, and lime, alone or combined with phosphoric acid, has been found of value, as has been the use of cod-liver oil rubbed into the legs and abdomen. Arsenious acid and iron will also be found beneficial.

Flat chest, especially the form resulting from avocation, is irremediable unless the occupation be changed early, but some advantage may be had by employing treatment similar to that employed in round shoulders.

Pigeon breast should be treated principally by manipulation, massage, breathing exercises, and gymnastics, in order to stimulate the respiratory muscles.

Scoliotic conditions resulting in thoracic deformity should receive the same treatment as that advocated for scoliosis. When kyphosis is present, the improvement is not satisfactory, but undue pressure of the bands upon the spinal support should be corrected where it is possible. In incipient hollow chest from atony of the spinal muscles exercises should be given and the use of a shoulder brace will be found beneficial.

In all cases of thoracic deformity gymnastic exercises are especially valuable in order to develop the muscles of the chest and back, and also the respiratory muscles. The movements may be both passive and active. Electricity is of marked value in some conditions. The expansion and development of the chest and back muscles being the main object of the treatment, all injurious external pressure should be carefully guarded against, such as the wearing of apparatus which may compress the chest, and particularly should corsets be avoided.

CHAPTER III.

SACRO-ILIAC DISEASE.

Sacro-iliac disease is an acute or chronic tuberculous affection of the sacro-iliac articulation.

Synonyms.—*English*, Sacro-coxitis (Hueter); Sacroarthrocace. *French*, Sacrocoxalgie. *Italian*, Malo di Boyer. *Spanish*, Mal sacroiliac.

This disease is fortunately uncommon, although probably more common than is generally supposed. Existing apart from spondylitis in the lower lumbar spine, it is of rare occurrence. The first accurate account of the affection was made by Boyer, in 1821, since which numerous theses and monographs have been written, the best being those by Hahn, Nélaton, Erichsen, and Van Hook.

Etiology.—It is an affection of early adult life, but, as Velpeau remarked, it is met “at all ages, in private and hospital practice, among the rich and poor.” The negro race is not exempt, as the writer has observed a typical case in a young mulatto woman. Poore reports cases which he has seen in children. It is, however, rare in children. Thus, according to Van Hook, in thirty-two cases in which the age was recorded, “less than 22 per cent. of the cases were below fifteen years of age; the same proportion were between fifteen and twenty years of age; while in the fifth lustrum of life we find twelve cases recorded, just $37\frac{1}{2}$ per cent. of the whole number. All the remaining years of life furnish only six cases.” Added to a specific constitutional predisposition, the exciting cause is usually found in exhaustion, exposure, or traumatic violence. One case directly due to injury is recorded by Louis. Among the cases recorded were gunners, exposed to the sudden jars of jolting caissons; laundresses, and children addicted to violent sports. Young cavalry soldiers are often subjected to this disease, the exciting cause being the traumatism from the equestrian exercise, the sacro-iliac joint in this exercise being obliged to bear the entire weight of the trunk. Sex is an element, but the greater exposure of males to traumatism is partially offset by the greater liability of parturient women.

Pathology.—The lesions are identical with tuberculous joint disease

elsewhere. The affection may begin in the synovial membrane or bone, and extend rapidly to the cartilaginous constituents of the articulation. Disease of the bones is far more frequently met than that of other structures, and on account of the strength and thickness of the posterior ligaments, and the absence of definite subjective symptoms in an early case it is rarely recog-

nized before suppuration has occurred or the bone has become considerably involved. The anatomic construction and pathologic features most resemble Pott's disease of the vertebra, as pointed out by Delens. Tubercular foci and sequestra are formed, and masses of bone may be discharged per rectum. Granulation tissue may form in the bone, or, invading the soft tissues, give rise to abscess formation. The inflammation is more often of the caries necrotica than of the caries sicca type, two varieties distinguished by König as a "moist form" and a "dry granulating form."

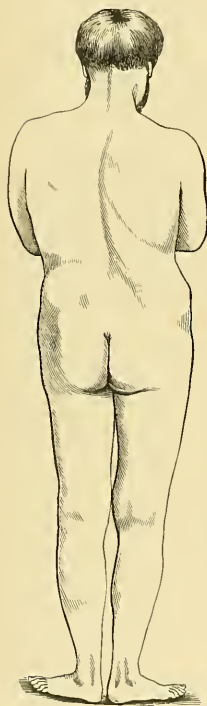


FIG. 287.—SACRO-ILIAC DISEASE, SHOWING CHARACTERISTIC ATTITUDE.

Symptoms.—The cardinal symptoms of sacro-iliac disease are five, in the order of succession as follows: pain, lameness, changes in attitude and length, tumefaction, and abscess. The pain, at first intermittent or fugitive, becomes in time constant and severe. It varies in situation and may be referred to the course of the sciatic nerve. The local pain in sacro-iliac disease is a shooting pain in the median line of the affected region, radiating outward to the remote distribution of the dorsal nerves. This pain occurs usually on arising from bed after a night's repose, and frequently passes off within five minutes after the patient has begun to move about. It is aggravated by coughing, laughing, urination, or defecation, and pressing the sides of the pelvis together pro-

duces pain in the joint, a symptom almost pathognomonic. The pain is often accompanied by the sensation as if the body was falling apart. Sensitiveness upon pressure is present posteriorly and may be elicited anteriorly per rectum. After abscesses have formed, the pain may radiate to the anus, the leg, or extend to the knee. On account of the peculiar anatomic characters of the joint, muscular spasm and atrophy, such common and prominent symptoms in affections of other

joints, are not conspicuous, but atrophy of the muscles of locomotion occurs. In walking the gait is very cautious, all jar is avoided, and hence the patient walks mainly upon the ball of the foot and never upon the entire sole. Lameness occurs early, walking is difficult, the diseased limb is favored as much as possible, the body is inclined to the sound side, and the pelvis tilted into the so-called "position hanchée" of Hattute, which Sayre regards as characteristic. Later, the patient becomes bedridden, lying upon the unaffected side. The elongation of the limb is apparent from downward rotation of the innom-



FIG. 288.—SACRO-ILIAC DISEASE.

inate bone, and not from actual increase in length, a fact easily demonstrated by measurement between the bony joints. Swelling appears first over the head of the sacro-iliac joint, and later extends to and alters the shape of the buttocks. The local temperature is elevated, a fact utilized by Sayre for diagnostic purposes. Suppuration does not occur in all cases, and when present is most common during the late stages of the affection. In fifty-five collected cases, abscesses occurred in thirty-eight. When formed, abscesses find their exit in the direction of least resistance, becoming at once either intra-pelvic or extra-

pelvic, in the proportion of 61.8 per cent. of the former to 38.2 per cent. of the latter. The direction and termination of these are well shown in the following table, modified from Van Hook:

TABLE OF ABSCESES IN SACRO-ILIAC TUBERCULOSIS (AFTER VAN HOOK).

Extra-pelvic	Pointing posteriorly (<i>i. e.</i> , immediately over the joint).		
	Dissecting upward (pointing in lumbar region).		
	Dissecting downward (pointing in the gluteal region).		
Intra-pelvic	Dissecting upward to lumbar region.		
	Dissecting outward and forward.	Under periosteum.	Without finding exit anteriorly. Toward insertion of iliopsoas.
		Under iliopsoas.	
	Dissecting directly downward.	1. Out through sciatic notch.	Through gluteus.
		2. Inward toward ischio-rectal fossa to	Downward to thigh.
			Rectum.
			Perineum or anus.

Diagnosis.—Though the diagnosis of sacro-iliac disease can usually be readily made, there are several affections with which it may be confounded. These are: lumbo-abdominal neuralgia, sciatica, lumbago, psoriasis, caries and necrosis of the iliac bone, lumbar Pott's disease, and hip disease, the diagnostic points of which have already been given. In addition to these, it may be remembered that this joint is liable to many forms of joint disease—acute and chronic suppurative inflammations, primary, osteomyelitic, and metastatic; acute articular and gonorrheal rheumatism and arthritis deformans, and is also the seat of tumors, fibro-plastic hydatids, and enchondromas. Lumbo-abdominal neuralgia may be distinguished by the superficial and diffused character of the pain, its resemblance to other forms of neuralgia, and particularly by attention to the painful points of Valleix. Sciatica may be recognized by its occurrence in older persons, the situation of the pain below and not above the gluteal muscles and extending down the back of the thigh, slight flexion of the limb, deformity of the pelvis, or other signs of articular disease. In lumbago the tenderness is over the lumbar region, not over the joint; it is bilateral in distribution, increased by flexion and extension of the trunk, and unaccompanied by any symptoms of the disease of the sacro-iliac joint. In psoriasis the thigh is flexed and the foot rotated inward; pain is absent from the posterior part of the joint, but is caused by extension of the thigh, and pressure upon the sides of the pelvis does not elicit pain. Caries and necrosis

of the ilium are to be distinguished by the absence of pain in standing and walking, elongation of the limb, and tilting of the pelvis on the affected side. The exploration of fistulas will facilitate the diagnosis. Lumbar Pott's disease offers a condition which is very confusing, and one best distinguished by its occurrence during childhood, the presence of spinal deformity, of tenderness over the affected area, with general rigidity of the spinal column, and absence of elongation or other symptoms of disease of the sacro-iliac articulation. There is no lameness in walking.

Prognosis.—The prognosis of advanced sacro-iliac disease has always been considered unfavorable, a fatal result usually occurring from long-continued suppuration and hectic fever, and secondary tuberculosis. Among cases seen earlier, recoveries were recorded. It is to be considered, however, that the symptoms detailed of many non-suppurative cases hardly warrant the diagnosis of sacro-iliac tuberculosis, and by that much detract from the weight which they would otherwise give to a favorable prognosis; and that the fatal termination and consequently unfavorable prognosis of the suppurative cases have more frequently been due to the character of the operative interference than to the nature of the affection. There seems to be no good reason for believing that tuberculosis of the sacro-iliac articulation is governed in its fatalities by other laws than those which govern the fatalities in tuberculosis of other joints. As in spondylitis, deaths occur from tubercular infection of other organs quite as frequently in the dry as in the moist form of disease, provided there be no operative interference. Death from prolonged suppuration is exceedingly rare when tubercular abscesses are subject to the let-alone treatment, and rarer still is death from septic infection. On the other hand, there can be no reasonable doubt that any operative interference increases the risk of general tubercular infection; and unless the operation be strictly aseptic, and the prolonged subsequent dressings be kept so, the risk of septic infection of a large cavity connected with carious bone is considerable.

The prognosis in children is much better than in adults.

Modern statistics indicate a strong tendency to an unfavorable prognosis in the moist variety, but a decidedly favorable tendency in the dry granulation form. Thus, in 16 out of 17 cases in which abscesses did not occur, the recoveries were 94 per cent., while in 38 cases in which abscesses occurred, the recoveries without operation were only 3, or 7.9 per cent.

Treatment.—The proper treatment will depend upon the stage in which the disease is recognized and the variety of the affection. Whether of the

dry granulation type, or the moist form with abscess formation, in either the hygienic conditions should be the best that circumstances permit, and the general health should be sustained and improved by stimulants, tonics, etc. In the early stage the joint should be immobilized with plaster-of-Paris, leather, or some other form of apparatus, and the patient, placed on crutches, wearing a high shoe upon the foot of the sound side, may enjoy the benefits of fresh air and sunshine. Extension by weight and pulley should be employed at night, and later may be used constantly with the patient in the recumbent position. When the pain is severe, counter-irritation with iodine, cantharidal collodion, or thermocautery is indicated. When abscesses form, they should be freely opened and thoroughly drained, and any sequestra found should be removed and the walls thoroughly curetted, the object being to remove, if possible, all tuberculous matter. Drainage is best effected with iodoform gauze, and full aseptic precautions should be observed. If the abscesses be intra-pelvic alone, the disease may be reached without the extensive removal of healthy bone required in the operation of Tilling, by employing the method of Van Hook. A vertical incision, two or three inches in length, over the posterior spinous process of the ilium is first made, the bone is denuded of periosteum and connective tissue by scraping, and with a chisel small fragments are removed from the exposed bone until the anterior surface of the diseased joint can be exposed and thoroughly curetted with curved instruments. Iodoform gauze packing and an aseptic dressing complete the operation. Severe cases may demand excision of the sacro-iliac synchondrosis.

CHAPTER IV.

HIP-JOINT DISEASE.

Hip-joint disease is a chronic tubercular lesion of the coxofemoral articulation, beginning usually as an osteitis or synovitis and terminating in recovery, ankylosis, or complete destruction of the joint.

Synonyms.—*English*, Morbus Coxarius; Morbus Coxæ; Hip Disease; Tuberculous Disease of the Hip; Chronic Articular Osteitis of the Hip; Chronic Epiphysitis of the Hip; Medullo-Arthritis; Coxalgia; Coxitis; Morbo-coxario. *French*, Coxo-tuberculose; Coxalgie; Coxarthrocace; Femoro-coxalgie; Cox-opathie. *Italian*, Malocoxario, Coxiti, or Coxotuberculosi. *Spanish*, Coxo-tuberculosis.

Many of these terms are misleading or at most unsatisfactory. The term here used, hip-joint disease, is now accepted by common usage, but for scientific purposes the terms chronic articular osteitis (Gibney), or coxo-tuberculose (Lannelongue), would best suit the purpose.

Frequency.

The frequency of hip-disease in surgical practice is illustrated in the fact that in 1000 cases of tuberculous bone disease collected by me 421 were cases of this affection, and the relative number of cases of hip disease compared to diseases of the other articulations is shown in the following list of cases from the same source:

Vertebras,.....	416	41.6 per cent.
Hip-joint,.....	421	42.1 "
Knee-joint,.....	103	10.3 "
Ankle-joint,.....	33	3.3 "
Shoulder-joint,.....	2	0.8 "
Elbow-joint,.....	17	1.7 "
Wrist-joint,.....	8	0.2 "
	1000	100 per cent.

Of the 7932 cases admitted to the Children's Hospital of Philadelphia, 592 were cases of hip-joint disease. Of the two sides, the right limb appears to be more frequently affected: thus Whitman found that 53 per cent. were

on the right side, and in my own statistics 52.7 per cent. were on the right, and 47.3 on the left.

Bilateral Hip Disease.—It affects usually but one side, but instances of double hip disease occur. Thus Whitman found 11 cases in 1000 cases of hip disease, and in my own statistics in 421 hip cases there were 18 double cases; of these, 12 occurred in males and 6 in females.

Etiology.

The causes of hip disease are both predisposing and exciting. The age, sex, heredity, hygienic surroundings and social condition, and the peculiar anatomy of the joint are all predisposing factors; the exanthemata of childhood, traumatism, and diseases of the neighboring organs being exciting causes.

Age.—Though occurring later in life in exceptional instances, hip disease is essentially a disease of infancy and childhood, and age may be considered one of the most important predisposing factors.

Congenital cases have been observed and reported by Broca, Verneuil, Morel-Lavellee, and Padieu. All observers report occasional cases during the first year, but, as a rule, hip disease attacks children between the ages of two and thirteen years. Thus, of 365 cases collected by Sayre, 221 were under fifteen years and 121 of these were under five years; of 360 cases collected by Bryant, 309 were under twenty years, and of these 126 were under four years; of 619 cases collected by Wright, 480 were under fifteen years, and of these 130 were under six years; of 860 cases reported by Gibney, 84½ per cent. of all cases occurred before fourteen. Of my own statistics of 421 cases, 351 occurred before the fifteenth year, and 273 of these before the tenth year. They were distributed as follows:

Less than 1 year,.....	5
Between 1 and 5,.....	132
Between 6 and 10,.....	136
Between 11 and 15,.....	78
Between 16 and 20,.....	29
Between 20 and 25,.....	17
Between 26 and 30,.....	13
Between 31 and 35,.....	7
Between 36 and 40,.....	4
Between 41 and 45,.....	3
Between 46 and 50,.....	2
After 50,.....	0

The relative frequency of hip disease at this early period is probably due to the following causes: the frequency of tuberculosis in childhood; the active

growth and immature nature of the epiphyses and joint constituents generally; the greater liability of children to fall; the greater bodily activity of youth, which favors the development of grave disease from slight injury.

As there is usually some lapse of time between the occurrence of the injury and the onset of the disease, it is interesting to note the various periods which may elapse in a series of cases. I have collected 100 consecutive cases of hip-joint disease from the case-books of the Hospital of the University of Pennsylvania, which show the following:

(a) Within two weeks,.....	43
(b) Two weeks to three months,.....	28
(c) Three to six months,.....	15
(d) Six months to one year,.....	7
(e) One year to eighteen months,.....	6
(f) Longest period three years,.....	1
	100 CASES.

Instances of primary hip disease after twenty-five years are rare. Wright has recorded one occurring at fifty-four years, and Paget has pointed out the fact that people over sixty are more often "scrofulous" than people between thirty and fifty, and referred to the frequency of hip-joint disease in the aged. Relapses, particularly between thirty and forty years of age, are common.

Sex.—Though sex is considered by most modern writers to be of no importance as an etiologic factor, the greater number of males over females in all statistics remains. Thus, according to Ashhurst, of 100 cases admitted into the Children's Hospital of Philadelphia, 61 were boys and 43 were girls; and Lannelongue found in 100 cases 57 boys and 43 girls. Likewise, of 619 cases recorded by Wright, 371 were males. Whitman in his 1000 cases found 553 (55.3 per cent.) males, and 447 (44.7 per cent.) females, and in my own statistics of 421 cases, 247, or 58.7 per cent., were males, and 174, or 41.3 per cent., were females. This preponderance of males over females among patients suffering from hip disease has been assigned to two causes: the greater liability of males to injury from their more boisterous habits, and the existence of phimosis as an exciting cause. The former will be considered under the exciting causes; but the latter, since it concerns the sexes directly, may be given here.

Barwell many years ago observed a singular coincidence between hip disease and phimosis, and reported that in 100 cases examined in 6 only was there no phimosis; 66 had the affection severely, and 28 slightly.

Since this report, Sayre, Wright, and others have found it as one of the exciting causes of hip disease.

It has also been suggested that Hebrew boys were particularly liable to inoculation of tuberculosis during the ceremony of circumcision, as has been referred to under the general subject of tuberculosis in Part I; but since the introduction of antiseptic methods among the surgeons this danger may be considered overcome. While the danger is more frequent among males, sex has but little influence as a predisposing cause.

Heredity.—The difficulty of correctly ascertaining the influence of inherited disease is at once evident when we realize the inclination of both parents and patients to deny the existence of tuberculous disease in their ancestors or near relatives, and their desire to establish, if possible, a traumatic origin for the affection.

For example, out of my 1000 cases of tuberculous joint disease before referred to there was: Hereditary predisposition, 240, or 24 per cent.; traumatic predisposition, 298, or 29.8 per cent.; acquired predisposition, 462, or 46.2 per cent.

For this reason the greater proportion of statistics are inaccurate and only approximate the truth, the error being, however, on the side against inheritance. Notwithstanding this, both experimental research and clinical investigation tend to establish the tuberculous tendency as a predisposing cause. The direct transmission of tuberculosis has been established. This subject has been considered under the etiology of tuberculous joint disease—Part I. Clinical analyses of hip-joint cases have variously estimated the percentage of patients who have either a hereditary or an acquired diathesis. Gibney, after a careful analysis of 596 cases of tubercular joint disease of the different joints, of which 265 were diseases of the hip-joint, could find only one case which did not present either an inherited or acquired diathesis. Of these 265 cases, phthisis occurred in the father's family 53 times, in the mother's 56; and diseases unquestionably tubercular in the fathers 10, and in the mothers 18 times, besides the syphilitic, rheumatic, and alcoholic diathesis a number of times.

Traumatism.—The injuries which are most frequently followed by tuberculosis of the hip is a fall from a height, the patient alighting with the feet widely separated, producing an injury to the round ligament or head of the bone, and a lateral fall, striking on the trochanter; occasionally the exciting cause is a severe twist of the hip produced by the foot being caught and the person being suspended and wrenched by the fall.

Pathology.

Though hip disease is fatal in a certain number of cases, the opportunity for anatomic study at an early period is rarely offered, hence the contradictory statements which exist in regard to the seat of the initial lesion. The pathologic lesion in the advanced stage is a destructive tubercular osteitis, resulting in interstitial absorption or caries of a portion or the entire constituents of the joint, and as a tuberculous lesion it does not differ from tuberculous osteitis elsewhere, and will be found fully described under Part I. A sufficient number of early autopsies have fortunately been observed to settle definitely the fact that the initial lesion may originate in any one of the structures which constitute the articulation, occurring more frequently in certain localities than in others. Thus in a case reported by Agnew, of a lad suffering from incipient coxalgia, who died of tuberculous meningitis, the inflammatory redness occupied the cartilage a short distance round the acetabular and femoral attachment of the ligamentum teres. Holmes also reports two autopsies in incipient coxalgia, in which he noted inflammatory lesions of the synovial membrane and round ligament, and one of erosion of the ligament. Marjolin and Gosselin, Martin and Collineau, report similar cases. Autopsies at a later period of the disease show the head of the femur and acetabulum frequently involved, but as far as known there are no specimens recorded of initial lesion of the acetabulum, it being usually secondarily affected.

In 61 specimens of hip excision analyzed by Müller, it was found that the disease began in the bone in 47 cases, in the synovial membrane in 3, but it was impossible to state where it originated in 3.

According to Habern, from an analysis of 132 hip resections in Volkmann's clinic, primary acetabular infection is more frequent. Thus, a caseous focus of the acetabulum was found in 50, with a sequestrum in 31; a focus was found in the femoral head, neck, or trochanter in 23; foci in both acetabulum and femur in 7; and the disease was so far advanced in 29 that it was impossible to locate the primary lesion. While Nichols believes that the foci in the bone preceded the joint lesion in all of the 120 tuberculous joint specimens examined by him, all systematic writers describe a primary synovial form of tuberculosis occurring in from 16 to 35 per cent., and it is the common belief among orthopedic surgeons that the tuberculosis may be primarily synovial.

The majority of surgical authorities at the present time believe in the osseous origin of chronic tuberculous osteitis, while a few still cling to the theory of a purely synovial origin.

The origin of hip disease from a psoas abscess or from a tuberculous adenitis is primarily synovial by contiguity of structure. The recorded cases of primary infection of the ligamentum teres are sufficient to establish the occasional primary ligamentous origin of the affection. In adults a synovitis may terminate in a tuberculous arthritis. With these exceptions personal observation confirms



FIG. 289.—SKIAGRAPH OF UNILATERAL HIP-JOINT DISEASE.

the statement of Lannelongue, that in the majority of instances "*la coxo-tuberculose est primitivement osseuse*"; a statement more recently confirmed by the pathologic studies of Nichols.

The microscopic appearance resembles tubercular osteitis elsewhere. Its extent and destructiveness will depend somewhat upon the initial lesion

and the virulence of the process. In the head and neck of the femur the lesion may be limited to a circumscribed area; the epiphysis may be completely destroyed, separated, and lying loose within the joint—in the latter the sequestra being cut off by granulation tissue, the process being a *caries necrotica*. In



FIG. 290.—SKIAGRAPH OF BILATERAL HIP-JOINT DISEASE.

rare instances the entire cartilage is separated and raised up like a hood by the formation of fungous granulation tissue beneath. When the inflammation commences in the sound ligament microscopic section shows active proliferation of the cartilage cells at the insertions of the ligament to the acetabulum and to the head of the bone, gradually extending to the cartilage and to the

bone. In the acetabular variety the cartilage is frequently infected secondarily from contiguity of structure from the diseased head of the bone in contact with it.

In the severer forms all the components of the joint are infected and destroyed. The synovial membrane, at first thickened, ultimately disappears, the head and neck become carious and have a "worm-eaten" appearance or these portions may entirely disappear; the acetabulum is excavated or entirely perforated by the ulcerative process. True dislocation seldom occurs. The absorption of the cavity by ulceration and new bone formation

around the acetabulum—the so-called "traveling acetabulum" so characteristic of the disease—have given rise to this impression. A true dislocation is, however, possible by the head of the bone being pushed out of the acetabulum by a tuberculous mass within its cavity.



FIG. 291.—TUBERCULOSIS OF HEAD OF FEMUR (Krause).
a, Separation of cartilage in form of hood.

In those cases of osteitis in which interstitial absorption occurs—caseation without suppuration—a residual abscess may result. In this form of inflammation—the so-called *caries sicca*—the affection may exist for years with extensive destruction of the carti-

lages and bones, with consecutive dislocation but without a drop of pus. In such the granulations are firmer, almost cartilaginous in consistence, tending to atrophy and cicatrization—a process analogous to cirrhosis. In a large proportion of cases, where the disease runs its course unchecked by treatment, suppuration occurs, the abscesses finding exit in the direction of least resistance, their course and termination being comparatively uniform.

Profuse suppuration from the joint is always a sign that part of the synovial membrane has not yet been destroyed, or that there are large abscesses near the joint; the secretion from fungous granulations is less abundant, serous or mucous. Periarticular abscesses, and suppuration of the cellular tissue about

the joint, whether associated with the joint disease or independent of it, increase the amount of discharge.

The disease may halt and recover at any stage. If the disease terminate before the articulation has suffered much mutilation, it may return by a process of repair almost to its original condition. If ankylosis occur, however, the femur and ilium become consolidated and fixed by firm fibrous or bony union, the articulation being protected against dislocation by an osteoplastic osteitis.

Patients with hip disease are exceptionally attacked by phthisis pulmonalis, though osteitis of other parts is common, as of the vertebrae, tarsus, carpus, elbow-joint, shoulder-joint, etc. When phthisis occurs in patients suffering from hip disease, there is always a subsidence of the latter disease, and sinuses, if present, cicatrize as a result and not as a cause of the pulmonary disease.

It is because of this apparent antagonism that exists between the tubercular diseases that it is, moreover, unusual for two grave manifestations of tuberculosis to be active at the same time—one will become manifest, while the other is observed to improve or subside.

When the localized tubercular process in the hip-joint infects the general system, tubercular meningitis or general miliary tuberculosis results.

Symptoms.

The symptoms of well-established hip disease, taken together, are so characteristic that the affection is evident at a glance, and yet the symptoms indicating the commencement of this disease are so obscure that it is frequently mistaken for rheumatism, and still more frequently for knee-joint disease. Distinct remissions of all the symptoms may occur, and these may be repeated many times—in one instance reported by Shaffer,* as many as seven—before the disease becomes established.

It has always been considered most convenient, for purposes of description, to divide hip disease into three stages:

1. The stage of onset.
2. The stage of apparent lengthening.
3. The stage of real shortening.

While each stage represents definite groups of symptoms peculiar to itself and corresponding to the pathologic changes occurring in the joint in (1) the stage of localized bone disease, (2) the stage of joint involvement, and (3) the

* "Tr. Orth. Assoc.," vol. xv, p. 258.

stage of destruction of the capsule and of external suppuration, it has not been deemed desirable by recent writers to make such a division; but I am of the opinion that there is nothing gained and much lost by omitting this method of classification, particularly as it describes the most common form of hip disease. This form will be designated in the following classification as the chronic ulcerative variety.

The pathologic conditions embraced in the comprehensive term "hip disease" include a number of well-marked types. These have been classified by Lovett* under four heads: (1) the destructive, (2) the painful, (3) the quiet, or painless, (4) the transient, or ephemeral; each of which corresponds to a peculiar type of the pathologic process. Park has suggested a division into: (1) chronic, (2) fibroid, (3) septic infectious (pyogenic), (4) mixed form.

I have described three groups,† in which I include the painful form under the head of the chronic ulcerative type, as follows:

1. Acute tubercular form. (Miliary.)
2. Chronic ulcerative form. (Pyogenic miliary.)
3. Chronic tubercular form. (Fibroid.)

This division corresponds with the manifestation of tuberculosis in the lungs, the acute miliary, the chronic ulcerative, and the fibroid phthisis.

These three groups may be described as follows:

1. The acute tubercular form. This type of hip disease is the analogue of acute pneumonic tuberculosis, commonly known as galloping consumption. It occurs in both children and young adults with inherited tendency and slight resistance. Two types may be recognized—a synovial and an osteitic.

(a) In the synovial variety the onset is abrupt and acute, and usually in an individual who has previously enjoyed good health, although in many cases there may be a history of exposure to cold, or of traumatism. If the fungous granulations are scanty, there is copious effusion, *tuberculous hydrops*, marked fluctuation, slight deformity, severe pain, and normal temperature. The condition may terminate at this stage or may become a fungous synovitis.

"If granulation tissue be abundant, there is little or no effusion in the joint, slight or no fluctuation, extensive deformity, without much suffering, and with slight fluctuations of temperature from the normal. Suppuration may occur in the granulations, and pus may accumulate in the joint until the capsule is ruptured and general infection occurs, or a spontaneous or artificial opening

* "Boston Med. and Surg. Jour.," April 13, 1892.

† "Med. News," April 15, 1893.

exposes the individual to infection with pus-microbes from without, with rapid impairment of the general condition, pyrexia, hectic and progressive anemia, and emaciation.

“(b) In the osteitic variety the commencement is likewise sudden in persons debilitated from acute infectious diseases, or from any cause. Pain initiates the attack, and is a prominent symptom throughout the disease. Localized tenderness on pressure is early present, and is one of the most positive indications of osteo-tuberculosis. There is little swelling or edema, until the para-periosteal structures become infected. Then the para-articular tissues become markedly indurated, and abscess formation rapidly occurs. Muscular spasm, deformity, and atrophy are extreme. The pyrexia runs high, and the general condition rapidly deteriorates. This destruction is rapid and death may occur from exhaustion, tubercular meningitis, or, if the disease drags on into the chronic ulcerative form, from amyloid degeneration.

“While the disease is confined to the articular structures it is a pure, florid, rapid tuberculosis; but when ruptured abscesses and sinuses expose an exquisitely prepared tissue-soil to atmosphere infection, suppurative microbes inaugurate a local septic process, and finally a pyemia.

“2. The chronic ulcerative form. Under this heading may be grouped the great majority of cases of hip-tuberculosis in which the lesions proceed to ulceration and softening, and ultimately produce the well-known picture of chronic hip disease.

“A purely tuberculous affection from the first, it ultimately becomes in many cases a mixed disease, many of the most prominent symptoms of which are due to purulent cavities and septic infections.”

The general description which follows in this work represents this type of hip disease, the chronic ulcerative form.

“3. The chronic tubercular form. This group includes a class of cases which while not common are sufficiently numerous to form a well-recognized type. The onset is gradual and the progress of the disease slow. Muscular spasm is an early and constant symptom, fixing the limb rigidly in the majority of instances. In a few, particularly when there has been much shortening, there may be great mobility without pain.

The local sensibility is not increased and pain as an important symptom is absent. Night cries may be present, but are insignificant. Muscular atrophy and shortening are the prominent characteristics. Abscesses seldom occur, but when present are accompanied by extreme shortening of the limb,

and in some instances entire destruction of the head of the femur. The tendency is toward recovery, with great shortening, extreme atrophy, and firm, fibrous ankylosis. The condition is one of sclerosis and induration with gradual shrinkage, from the superabundance of fibrous tissue, the tendency of the pathologic process being conservative and healing."

Stage of Onset.—The symptoms indicating the onset of the disease are very insidious, and consist of lameness, pain, induration about the joint, limitation of motion, muscular atrophy, glandular engorgement in the neighborhood of the joint, together with slight constitutional derangement.

Lameness. Among the earliest signs which denote this disease in its incipency is a slight limp observed in the gait of the child. This may be noticeable in the morning on rising from bed, and generally passes away in a short time. It is more marked after a previous day of great activity. But, as a rule, the limp occurs later in the day, in this manner differing from spine disease, in which the pain and stiffness are most marked in the early morning on arising. This limp is partially due to a stiffness about the joint, and to the pain which is also present at this time, and is aggravated by motion, though it may be absent in any or all of the stages of the disease.

Pain. Accompanying this limp pain is an early and frequent symptom, and is usually referred to the knee. It is usually periodic, evanescent, appearing suddenly while the child is at play, or coming on in the latter part of the day, and disappearing during the night. This pain in the knee has been variously explained. It has been ascribed to the pressure of the internal lateral ligament against the condyle of the femur, induced by the malposition of the limb. It is now, however, generally considered to be reflex, induced by pressure on the obturator nerve, transmitted to the short saphenous nerve, through the communicating branch, which passes between the femoral and profunda femoris vessels. Other explanations have been offered to explain this reflected pain. The pain is experienced upon the anterior and internal lateral surface of the joint over a considerable area, usually about the size of the patient's hand, differing in this respect from the localized pain in knee-joint disease, the area of which is small.

Induration. The marked swelling about the trochanter which is so characteristic of the later stages, is but slightly marked at this period. There is, however, if the trochanter be deeply and firmly grasped, some enlargement and hardening of the joint apparent; particularly is this marked if the disease is pelvic in its origin.

Limitation of motion. A state of spasm or muscular rigidity of the joint is among the first and most important symptoms of this disease. This is one of the earliest signs always present; it is very persistent, and is the result of reflex muscular spasm, accompanied by an unconscious automatic contraction of the muscles to fix the joint and diminish the jar in walking. This muscular rigidity, together with the atrophy which it induces, are the two most positive symptoms of hip disease at this stage. The limb is held in a position of slight flexion, and in some cases slight abduction. This constant tetanic contraction not only produces the malposition of the limb referred to, but by forcing the head of the bone against the acetabulum produces a destruction of the cartilage and an increase of pain. Associated with this rigidity about the hip-joint there is, often, also a muscular irritability of the lower erector spinæ muscles and the muscles adjacent to the joint. This muscular rigidity about the joint, when slight, may be noticeable only when extreme flexion and extension are made, the range of motion in the middle of flexion being slightly or not at all impaired. Anesthesia reveals the true nature of this rigidity, the muscular spasm entirely disappearing if no adhesion or muscular contracture exist.

Atrophy. Wasting of the muscles of the thighs and buttocks is characteristic of the disease. It occurs early and persists throughout the course of the affection. That this is not the atrophy of disuse is shown by the fact that it occurs so early and advances so rapidly. Paget designated it reflex atrophy, but Brown-Séquard's experiments led him to believe that the wasting is due to an irritation of the nerves, independent of the trophic centers. That the trophic centers are, however, affected would seem to be proved by the fact that not only do the soft parts waste, but the bone also becomes diminished, both in diameter and length.

According to Charcot and Vulpian, as the effect of the tetanoid spasm there occurs a change or "inertia" of the trophic centers of the spinal cord, while Saborin has suggested a molecular neuritis from direct involvement of the nerve filaments. The increased use of the sound limb also causes a relative hypertrophy which exaggerates the atrophy of the affected part.

In hip disease the atrophy is found to be greater as a result of fixation in the treatment of the condition. This was shown in the observations of Dr. Brackett, who in two groups of cases, in one of which fixation was employed and in the other of which free motion was permitted, found that the atrophy was much greater in the former group, amounting to 23 per cent. of the volume of the thigh and 17 per cent. of that of the leg, as compared with 1 per cent.

of the volume of the thigh and 0.89 per cent. of that of the leg. A certain amount of this atrophy is due to disuse, and also results from lack of function, the natural stimulus of the part.

The amount of atrophy is best estimated by circumferential measurements taken about the thigh, at points equidistant from the internal condyle, upon the affected and sound limb. In this manner the slightest degree of atrophy can be estimated, and will be found present in some cases even before the advent of pain. Similar measurements of the circumference of the calf, on either side, will demonstrate the absence of atrophy in them at this early period. This atrophy differs from the wasting of paralysis, in that the muscles retain their firmness or are unusually hard.

Glandular engorgement. Though the inguinal glands are frequently enlarged in patients of a strumous diathesis, the enlargement of the deep glands above Poupart's ligament is a frequent and early sign of this affection. Deep pressure in this situation reveals their presence, and palpation is painful. Attention has been particularly called to this by Lannelongue and other French writers, who have noted their presence even in the early months. The swelling of these inguinal glands is thought by some to indicate osteitis, but others believe they often indicate disease of the pelvis rather than of the femur. Their suppuration usually indicates pelvic disease.

General condition. The constitution at this early stage suffers but little, and in many cases the physical appearance but little indicates the grave pathologic process going on within. The appetite may be diminished, the digestion enfeebled, and the disposition irritable, but in the majority of cases the premonitory stage, if any, passes unobserved. In many of these children a large but unnatural accumulation of adipose tissue produces an impression of health which really does not exist. The deposit of fat may be greater on the affected side, and English writers have referred to this unequal distribution as a diagnostic sign.

Stage of Apparent Lengthening.—The second stage is marked by an increase of all these symptoms, and the advent of three other signs: "night-cries," suppuration, and grating, or joint crepitation.

Lameness. The slight limp referred to in the first stage is in the second stage a decided lameness, being due to the altered position of the limb in flexion, tilting of the pelvis and apparent elongation of the limb, or to actual shortening. In standing at rest the body-weight is transferred to the sound limb, and the affected limb is advanced and rested as much as possible.

Pain. The pain referred to the knee increases in intensity and duration, and to this is added pain in walking and upon motion. It is relieved by gentle traction on the line of deformity. So great may the sensitiveness of the joint become that the slightest motion or jarring causes excruciating agony. The pain is increased by forcing the joint surfaces together, but this is cruel and entirely unwarranted, since it adds nothing of diagnostic value. The location of the pain remains the same, and attempts to differentiate the locality of the bone lesion are unsatisfactory. Erichsen has suggested that a pain in the knee indicated "femoral coxalgia"; pain in the joint, "arthritic coxalgia," and pain in the iliac fossa, or side of the pelvis, "acetabular coxalgia." The pain increases with the distention of the capsule, and during the exacerbation of the disease, and usually ceases abruptly with the rupture of the capsule and the extravasation of the pus into the surrounding tissue. Though an early and persistent sign of the disease, pain may be entirely absent in any or all of its stages, so that as an individual diagnostic sign it is of little value.

Induration. Thickening and hardening about the trochanter is indicative of suppuration within the joint, and Wright considers it pathognomonic of it. It is therefore particularly characteristic of this stage. It is best recognized by grasping the trochanters with each hand, the thumbs in front and the fingers applied well down into the post-trochanteric fossa. In this manner the two sides can be carefully compared.

Limitation of motion. The position of the thigh is changed by the muscular spasm and the formation and accumulation of pus within the joint. The thigh is flexed, abducted, and rotated outward, the position having been demonstrated by experiments to be the one in which the capacity of the joint is greatest. The coxo-femoral joint is more or less fixed, and if the pelvis retains its normal position the flexed, abducted, and rotated position of the limb is not only unsightly, but unfavorable to progression. To overcome this flexion the pelvis is tilted downward; to overcome the abduction, which is essentially an unfavorable position for walking, the pelvis is tilted laterally; to overcome the rotation of the head of the bone, the pelvis is tilted on its axis toward the sound side, so as to render the anterior superior spinous process prominent and removed far from the axis of the trunk.

This alteration in the position of the pelvis is reflex in nature, and occurs consecutively with the osseous changes. That it is muscular and reflex is demonstrated by the fact that under profound anesthesia the fixation disappears and the limb may be placed and examined in a normal position. Later, how-

ever, after the contraction has existed for some time, this simple muscular contraction is succeeded by structural alterations of the muscles, capsule, bones, etc., which render the position of the limb more or less permanent.

The amount of deformity present can be ascertained by the employment of special instruments, as the compass of Martin and Collineau, the ingenious goniometer of Roberts, or they may be deduced with mathematic precision by the geometric procedures of Giraud-Teulon, and the elaborate tables of Bradford and Lovett. The simplest method and the one most generally employed consists in placing the recumbent body in such a position that the anterior-superior spinous processes are on a horizontal line, and measuring from these on either side to the internal malleolus on the corresponding side. By this means the real or bony shortening may be ascertained. If the amount of practical shortening be desired, measurement must be made from the umbilicus to each malleolus, and by comparing these—the real or bony shortening and the practical shortening—the degree of adduction and abduction may be obtained. This will be referred to again in speaking of diagnosis.

Atrophy. The wasting of the muscles progresses during the second stage, and to the atrophy from the tetanoid spasm, always present, is added an amount of atrophy from disuse commensurate with the severity of the disease and the inability to use the leg. In this manner atrophy of the calf and other muscles not affected during the first stage is added and contributes a new symptom to distinguish this stage from the first.

Flattening of the buttock. The abduction and flexion of the thigh and the atrophy of the gluteal muscles upon the affected side lead to flattening of the buttock and obliteration of the fold of the nates upon this side. This gluteal atrophy, like the adductor atrophy before referred to, is reflex and characteristic of the disease; the muscles, though wasted, are hard and tense, and not soft and flabby. Periarticular swelling also plays a part in the obliteration of the fold of the nates.

Night-cries. Though “night-cries,” or night-shoutings, may occur early in the disease, they are significant of this stage. They occur early in the night, and some patients lie awake as long as possible, fearful of their advent. As the child is losing consciousness, the muscular relaxation accompanying this stage allows pressure or friction of the tender surfaces within the joint, causes acute pain, a sudden awakening with a loud cry, and a violent spasm of the muscles to again fix the joint. After moaning and crying for some time sleep is again attempted, with, perhaps, a renewal of these disagreeable symptoms.

This may be repeated several times during the night, and indicates extension or an exacerbation of the disease. They resemble somewhat, but should not be confounded with, nightmare, or "night terrors," from which the severe pain and the absence of disagreeable dreams serve to distinguish them. The condition is described by patients old enough to distinguish symptoms, as extremely sudden and severe pain, followed by an aching or bruised sensation in the thigh and hip.

Abscess. Hip disease may run its entire course without suppurating, either extra-articular or intra-articular, the process being a *caries sicca*, a non-suppurative osteitis, which has already been described as the chronic tuberculous form; but, as a rule, abscesses are a frequent and serious complication. The presence of pus indicates the destructive character of the osteitis, though extensive collections may spontaneously undergo caseation and absorption without much destruction of tissue, a "residual abscess" resulting. They occur but rarely during the onset, but may be the first symptom to attract the attention of the parent or the patient to the affected part. They are characteristic of this period, and occur from the sixth to the fifteenth month, though they may be much later. According to Lovett and Goldthwait,* of all the (sixty-three) cases examined with reference to this subject, abscess occurred within one year in 59 per cent., within two years in 13 per cent., in three to five years in nine cases, and in the seventh and ninth year one each. The frequency appears to be directly influenced by the efficiency of appropriate treatment, and the stage during which it is begun. Thus, the percentage of abscesses occurring in the series of cases collected by Gibney, Marsh, the Clinical Society's Committee, and Lovett and Goldthwait, is from 23 to 69 per cent., of which from 41 to 50 per cent. developed before the patients came under treatment.

The origin and course of the abscess will depend upon the location and extent of the tuberculous focus. From an epiphyseal osteitis the pus may extend in a course outside of the joint and become extra-articular; so, also, an extra-articular abscess may invade the joint. Suppuration in hip-joint disease coincides, in general features, with cold abscesses from osteitis elsewhere. The advent is usually without constitutional disturbance, but slight evening rise of temperature, slight rigors, and perspiration may mark its progress. The complexion is pallid from the increased number of white blood-corpuscles in the blood,—suppurative leukocythemia,—the appetite is capricious, but

* "Trans. Amer. Orthop. Assoc.," vol. ii, p. 86.

otherwise the general condition may be but little affected. Locally, the abscesses follow the fascias, and seek exit in the direction of least resistance, opening at some distance from the seat of disease, accumulating, in some instances, until they assume enormous proportions, or burrowing to great distances. The abscesses may open in many places; the author has counted fifteen; in the case of Lund there were no less than twenty-one different openings. The course and exit depend upon the location of the original disease, and attempts have been made to classify the different routes followed by the suppuration, and utilize the knowledge for diagnostic purposes. While the pointing is significant, it is not a positive indication.

In the 321 abscesses reported by König occurring in hip-joint disease the exit was as follows:

On the inner side (inside the femoral artery),...	26
Front of the joint (between artery and anterior superior spine),.....	126
Region of the trochanter, ...	63
Posterior surface, ...	49
In the pelvis,.....	41
In other situations,.....	16

Three varieties of abscesses may be distinguished, based upon the primary lesion: Arthritic, femoral, and acetabular. Suppuration occurs earlier in the acetabular than in the femoral variety.

In the arthritic variety, if the head of the femur does not press specially upon any part of the capsule, the pus will find exit at the inner side, and point at the inner side of the thigh among the adductors. If the limb be adducted and rotated outward, the head of the femur presses against the anterior part of the capsule, the weakest spot at the capsule, and gives way at that point. In this event the pus enters the sheath of the psoas and iliacus, simulating a psoas abscess, or burrows downward toward the inner side of the thigh. If the limb be adducted and rotated inward, the pus escapes at the posterior part of the capsule—another weak point—to enter the pelvis along the course of the external rotators, or, what is more common, points below the gluteus maximus.

In the femoral variety they open directly into the joint, to terminate eventually as the arthritic abscess before given, or, escaping from the bone, open upon the outer or anterior aspect of the thigh. An abscess opening upon the outer part of the thigh, below the trochanter, indicates disease of the caput femoris, and abscesses which burst below and in front of the great trochanter are indicative of disease of the femur.

In the acetabular variety, owing to the peculiar anatomic relations, purulent

collections vary much in their course and exit. They may burst through the capsule and point in the inguinal region, or, perforating the pelvis, may pursue a circuitous route before being eventually discharged. Abscesses opening in the pubic region denote disease of the acetabulum—the abscess being intra-pelvic or extra-pelvic, according as it opens above or below Poupart's ligament. A pubic abscess pointing above Poupart's ligament is usually due to pelvic disease on its inner aspect or to perforation of the acetabulum. Wright concludes that when an abscess points on the front of the limb above a line drawn through the upper border of the great trochanter, there is disease of the pelvis, and this is the more certain, the higher and the more internal the opening.

In the acetabular variety, in pelvic accumulations from perforations of the acetabulum, the pus (1) traverses the internal obturator muscle to become a gluteal abscess; (2) fills the internal iliac fossa, and becomes a pubic abscess; (3) burrows through the external obturator muscle to become an internal crural abscess, or (4) opens internally, traversing the obturator internal muscle to open into the peritoneal cavity, the rectum, urethra, bladder, vagina, and upon the skin at the margin of the anus. Abscess pointing between the scrotum or labium and the thigh is always of serious import, indicating pelvic disease. Gluteal abscesses may be due to disease of either the femur or acetabulum.

ORIGINAL TABLE OF ABSCESES.

VARIETY.	COURSE.	EXIT.
1. Arthritic	a. Through inner side of capsule. b. Through anterior and inner side of capsule. c. Through posterior part of capsule.	Inner side of thigh among adductors. Enters sheath of psoas and iliacus, and burrows to inner side of thigh. Along course of external rotators or below gluteus maximus.
2. Femoral	a. Directly into joint. b. Outer or anterior course.	As in arthritic variety, upon outer or anterior aspect of thigh below the trochanter.
3. Acetabular ..	a. Through anterior part of capsule. b. Perforates acetabulum: 1. Through internal obturator muscle. 2. Fills internal iliac fossa. 3. Perforates external obturator muscle. 4. Into peritoneal cavity.	In inguinal region below Poupart's ligament. As gluteal abscess. As pubic abscess. As internal crural abscess. Into rectum, urethra, bladder, vagina, and at verge of anus.

Though possible, it is rare for purulent accumulations to be absorbed after they have acquired a certain volume. When the pus reaches the surface, it appears as a tense fluctuating swelling, of uniform color, with prominent

superficial veins. When pointing occurs, the skin becomes red, thin, and ulcerates in one or more places. These, if small, readily heal after the exit of the pus; they break down into large tuberculous ulcers, or remain indefinitely as orifices of sinuses or fistulas filled with exuberant granulations. These fistulas afford some clue to the seat of the disease, but cannot be readily explored on account of the tortuosity of their course. Fistulas, originally pelvic, are distinguished by bearing-down efforts of the patient, causing the escape of purulent liquid.

As long as the bone disease is active the sinuses continue to discharge, and any attempt at their closure is followed by marked constitutional symptoms—headache, anorexia, pyrexia, and anemia. The sinuses may continue long after the local disease is healed, but the discharge will not be abundant.

Grating, or joint crepitation. From erosion of cartilage and exposure of the cancellous structure of the joint surfaces, grating, or joint crepitation from friction, may occasionally in severe cases be elicited. Great care must be exercised lest injury result from rough manipulation. This may be obscured, even where considerable destruction exists, by the presence of abundant granulations, or where but one point of the bone is denuded, or where two or more roughened surfaces exist but do not approximate.

General condition. In the second stage children suffering from this affection are often apparently robust, especially in the intervals between the exacerbations which characterize the affection. When, however, abscess occurs, and especially when suppuration is profuse from the sinuses, anorexia, pallor of the skin, fluctuations of temperature, irritability, and diarrhea mark the progress of the disease.

Stage of Real Shortening.—The third stage is characterized by the adduction, shortening, dislocation, or ankylosis of the joint, ending in recovery; or suppuration, destruction of the joint, adynamic symptoms, and death from some visceral lesion.

Pain. The “starting” pains and night-cries are, in the third stage, at times gradually, sometimes suddenly, relieved. A feeling of tension and tenderness remains, and may increase from the accumulation of pus. When the disease is very extensive, marked swelling occurs from edema of all the periarticular structures.

Dislocation is often attended with considerable abatement of pain—some times complete and permanent, sometimes transitory. Dislocation, particularly subluxation, is often attended with sudden and severe pain. The character

of the ordinary pain in this stage is not available to distinguish the form of the original disease.

Temperature. Patients suffering from hip disease have, as a rule, throughout the disease an evening elevation of one or two degrees above normal. When attacked by some intercurrent affection of childhood the temperature may be found one or two degrees above that of others affected by the same disease. A sudden rise of temperature to 103° or over during the early stages is not so likely to indicate abscess formation as a great range of daily temperature. Continued high fever or great ranges of temperature in the later stages of the disease would be significant of infection of the tuberculous collection by pyogenic germs.



FIG. 292.—MARKED ATROPHY AND DEFORMITY IN ADVANCED HIP-JOINT DISEASE.



FIG. 293.—EXTREME ATROPHY FOLLOWING HIP-JOINT DISEASE.

Limitation of motion. Adduction, flexion, and shortening characterize the position of the thigh in this stage. This change from abduction and apparent elongation of the second stage into adduction and shortening of the third stage may occur rapidly, the position of months or years being reversed in a day.

Capsular contraction and muscular spasm are probably the cause of the adduction, while the elevation and backward thrusting of the pelvis and muscular spasm account for the early shortening. Later, actual osseous destruction

and dislocation of the head of the femur are the true explanation of the real shortening observed.

Shortening. The actual shortening which occurs from destruction of the bones, with the addition of atrophy from disuse, amounts in time to a considerable real shortening. This is well shown in the following table from Dollinger:*

NUMBER OF CASE.	AGE OF INCEPTION.		DURATION OF DISEASE.		LENGTH OF FEMUR IN CM.		DIFFERENCES.	LENGTH OF TIBIA IN CM.		DIFFERENCES.
	Years.	Months.	Years.	Months.	Diseased.	Normal.		Diseased.	Normal.	
1,.....	8	6	..	6	28½	28	½	24	24	..
2,.....	3	4	..	8	23	24	1	19	19	..
3,.....	2	10	1	8	24	24	..	19.5	19.5	..
4,.....	5	..	2	..	29	30	1	23.5	23.5	..
5,.....	6	..	2	..	27	28	1	23	23	..
6,.....	7	..	2	..	32	33	1	27	27	..
7,.....	9	..	2	..	37	37	..	30	30	..
8,.....	1	..	4	..	22	24	2	18.5	19	0.5
9,.....	13	..	4	..	38	41	3	34	34	..
10,.....	4	6	5	..	32	34	2	27	27	..
11,.....	..	2½	6	..	26	27	1	21½	23	1
12,.....	13	..	7	..	38	40	2	33	33	..
13,.....	2	..	8	..	35	36	1	28	28	..
14,.....	6	..	8	..	38	38	..	31	32	..
15,.....	11	..	8	..	40	44	4	34	34	..
16,.....	5	..	10	..	45	44	4	34	34	..
17,.....	5	..	11	..	41	44	3	31	37	6
18,.....	6	..	14	..	44	48	4	36	39.5	3.5
19,.....	2	..	18	..	36	46	10	38	38	..
20,.....	2	..	28	..	44½	45	½	37.5	37.5	..

Occasionally where the disease has not progressed far real lengthening may occur in the diseased side, being partially due to traction, and to the stimulated growth through irritation of the epiphysis. After the disease is arrested the growth may continue, but does not keep pace with the sound limb, and the relative difference in the limbs increases, as was shown in a series of cases examined by Shaffer and Lovett.†

Though frequently described in systematic treatises, it is probable that true dislocation from hip-joint disease very rarely occurs.

In destruction of the head of the femur, erosion of the brim of the acetabulum, in the so-called "traveling acetabulum," perforation of the acetabulum by the head of the femur, or where the trochanter is pushed upward, the head remaining in the acetabulum, dislocation cannot be said to have occurred. True instances of dislocation are chiefly confined to the femoral variety, and if, as sometimes happens, it occurs without suppuration, from the

* "Zeits. f. orth. Chir.," 1892, Bd. i.

† "N. Y. Med. Jour.," May 21, 1887.

formation of a "fungous fibro-plastic mass" in the acetabulum, or where, by mere distention of the capsule, with rupture of the ligamentum teres, a new socket may be developed upon the dorsum ilii or within the obturator foramen.

With the adduction and shortening there are associated undue prominence of the buttock on the affected side, marked upward and backward obliquity of the pelvis, lordosis, and a compensatory double lateral curvature of the spine. The lordosis is the result of fixation or ankylosis of the thigh in a fixed position, the arching of the lumbar region forward and the dorsal region backward being necessary to maintain the equilibrium. Flexion and abduction combined produce a compensatory lordosis and lateral curvature.

Recovery.

Amelioration of all the symptoms, both local and constitutional, may occur at any period, but if suppuration has occurred, recovery with a shortened, somewhat ankylosed, and atrophied limb is all that can be attained by conservative measures. If the tendency is toward recovery, this will be indicated by the general improvement of all the constitutional and local symptoms. Gradually the sinuses cease discharging, and finally close, the swelling and induration diminish, and the limb becomes more or less ankylosed in the position which it has last assumed, either from position of recumbency or the use of apparatus. In mild cases without suppuration, and some cases even with suppuration, perfect motion may be secured as the reward for efficient treatment.

Destruction.

When the disease progresses toward a fatal termination the adynamia from excessive suppuration leads to death from exhaustion—the patient dies of amyloid degeneration of the internal viscera, tubercular disease of some distant organ, particularly meningitis, or succumbs from some intercurrent affection which otherwise would have been successfully resisted. When meningitis occurs Kernig's sign—flexion of the hip, knee, and sometimes the elbow-joints, when the patient assumes the sitting position—will be of no value, since flexion will be present in the hip from the local affection. In doubtful cases lumbar puncture should be performed.

Hip Disease in the Adult.—In the adult hip disease is far more serious, more difficult to diagnose, and more fatal. Not infrequently it is a secondary affection from an early healed focus. The course is less acute and suppuration

is frequent. It can with difficulty be distinguished from gonorrheal and septic arthritis, osteo-arthritis, etc. Early operation is required more frequently than in childhood, and mechanical treatment is beset with more difficulties.

Double Hip Disease.—The course of the disease differs somewhat when both hip-joints are affected. According to Ridlon, the disease seldom begins in both hip-joints at the same time, and the second joint may become diseased while the patient is resting in bed under treatment for the first joint, showing that traumatism may be excluded as a cause of the disease in the second joint

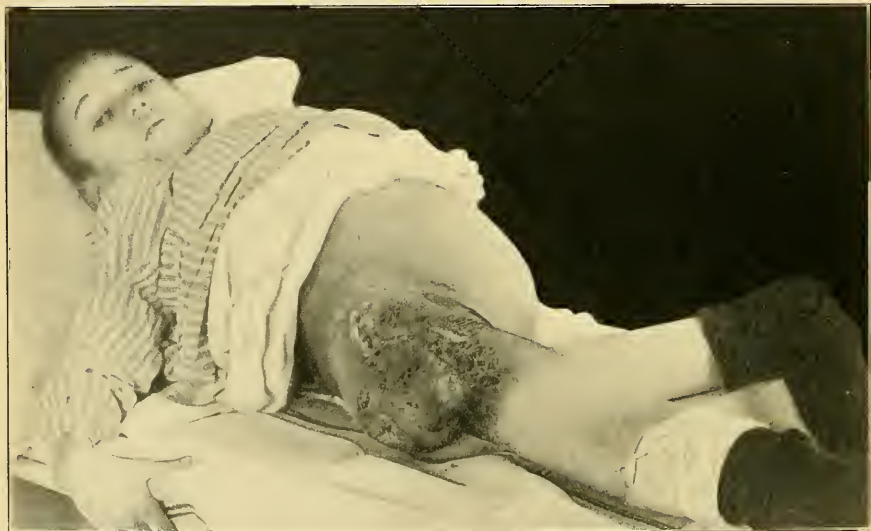


FIG. 294.—LAST STAGE OF HIP DISEASE.

in very many cases. The joint first affected is often the last to recover; the duration of the disease in the first hip is usually somewhat less than in the average case of hip disease, while the duration in the second hip is usually much less than that in the first. The amount of pain experienced in the second hip is usually less than that of the first.

In bilateral hip disease the duration of the disease in the first hip is usually somewhat less than that of the average case of hip disease, while the duration in the second hip is less than that of the first, the joint first attacked frequently being the last to recover.

Deformity is marked, and may differ on the two sides, there being adduction on one side and abduction on the other.

Ankylosis, with more or less adduction in one or both legs, may result with or without treatment. The result in severe cases is a "scissor-legged" deformity; locomotion is possible, progression taking place entirely by movement of the knee-joint. In females impregnation and safe delivery are likewise possible, though in severe cases impregnation can only be accomplished with difficulty, and parturition may become impossible from the marked adduction of the thighs, as in an instance at the Philadelphia Hospital which terminated fatally. The kyphosis and other pelvic deformities will be much influenced by the age at which the hip disease occurs, and particularly upon the disturbance of the normal anatomic forces, as pointed out by Schroeder.

Remissions.—Distinct remissions of all the symptoms may occur, and these may be repeated many times. These remissions are liable to occur in the early stage of the affection. A slight limp may disappear under recumbency for a week, only to return a month or two later. It may or may not be accompanied by pain, but upon careful examination a reflex muscular spasm will be found to be present during the intervals, and some slight alteration in the normal gait may be detected by an experienced person. Pain, when present, as also the soreness, may disappear, and during the interval the patient may resume his former activity, but subsequently the pain, limp, and discomfort will return. This may be repeated several times, in one instance, reported by Shaffer,* as many as seven times before the disease became established. Remissions may also occur in the later stages of the disease, but, as a rule, they are not so frequent, and the disease runs its course with greater regularity.

Diagnosis.

The general diagnostic signs of hip-joint disease are (1) limitation of motion, (2) atrophy, (3) lameness, (4) attitude of limb, (5) pain, and (6) swelling. These should all be carefully and thoroughly considered in arriving at a proper estimate of the condition of the joint in any given case. The symptom of "grating" is fallacious except in advanced cases, in which the associated symptoms will be so positive that its discovery will add but little of value. The first two symptoms are peculiarly significant of hip disease, and upon them in the

* "Trans. Amer.-Orth. Assoc.," vol. xv, p. 258.

earlier stages the most reliance can be placed. Later, the attitude of the limb, the pain, and the swelling are of great diagnostic importance.

Limitation of Motion.—Being a reflex tetanoid spasm, the first to appear, the most prominent while the disease exists, it is the diagnostic sign *par excellence* of hip disease. Its estimation in very young children, who through fright

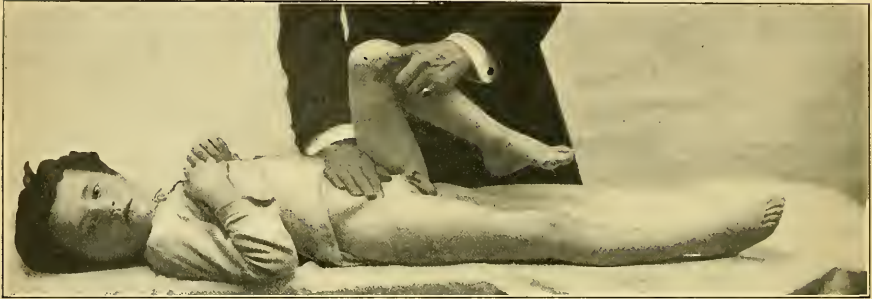


FIG. 295.—TEST FOR LIMITATION OF FLEXION IN HIP DISEASE



FIG. 296.—EXAMINATION FOR LIMITATION OF EXTENSION IN HIP DISEASE.

are apt to resist thorough examination, requires tact and patience. The examination should always be begun on the sound side to secure, if possible, the confidence of the patient, and flexion, extension, adduction, abduction, and rotation of the thigh, flexed at a right angle to the body, should each be separately investigated.

The tests in young and frightened children may be made with the child

lying on the mother's lap, but are best made with all clothing removed, upon a hard table or firm mattress.

In the earlier stages of disease forced flexion, forced extension, and forced rotation alone may give limitation, motion being perfect throughout a large portion of the arc in each direction and being limited only at the extremity of the arc of normal motion. Anesthesia overcomes the spasm, and hence should not, for diagnostic purposes, be employed.



FIG. 297.—EARLY STAGE OF HIP DISEASE, SHOWING LORDOSIS.

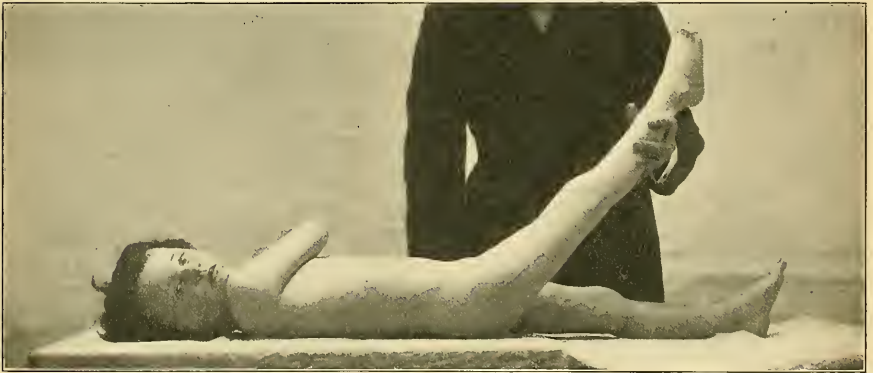


FIG. 298.—SAME, SHOWING DISAPPEARANCE OF LORDOSIS ON FLEXION OF THIGH.

The patient upon the back, and the pelvis being fixed with one hand, the other should grasp the ankle of the sound limb first, and firmly but gently flex it until it touches the abdomen or meets with resistance. The suspected limb should then be flexed in a similar manner and the resistance, if any, be compared; or the patient in the same position, the sound limb being flexed upon the body and held by the hand of the patient, the affected limb is then

examined for flexion, extension, and circumduction. The pelvis being again fixed, abduction can be estimated by separating first the sound limb and then the suspected limb as widely as possible from its fellow. Adduction can be estimated by crossing first the sound limb and then the suspected limb as much as possible, the pelvis being fixed. Extension is best estimated with the patient in the prone position. Fixing the pelvis with one hand, the sound limb is flexed at the knee to a right angle, and the thigh extended (backward) upward until it meets with resistance. The suspected limb is likewise placed in forced extension and the results compared.

The degree of rotation present is best ascertained by rotation with the hip flexed at a right angle to the body.

In the more advanced stages the estimation of limitation is easier, since the pelvis readily moves with the affected limb before the limit of motion is reached. Thus, in flexion from contraction of the psoas and iliacus muscles the popliteal space cannot (as on the sound side) be placed upon the hard surface upon which the patient lies without the arching (lordosis) of the lumbar region. Likewise the amount of abduction and adduction may be estimated by placing one hand upon the anterior superior spinous process of the ilium of the sound side, and gently but firmly abducting and adducting the suspected limb, the pelvis moving with the limb as soon as the limit of motion is reached.

In these estimations the greatest reliance should be placed upon limitation of motion at the extremity of the arc of normal motion.

Atrophy.—Atrophy of the muscles being the result of the reflex muscular spasm, appears very early in some instances while the disease is still confined to the epiphysis, and is one of the most important symptoms in arriving at a correct early diagnosis. The atrophy is not only greater than that in simple disease of the muscles, but being unilateral (in a single hip disease) and being confined to certain groups of muscles, is very characteristic. In the earliest stages the adductors only are atrophied, but later the obliteration of the fold of the nates occurs through atrophy of the glutei, and the calf muscles and all the thigh muscles share in the general atrophy.

Mensuration.—Measurement for atrophy is made by taking the circumference at the same level of both the thighs and calves with an ordinary tape-measure.

For the purpose of record, or where greater accuracy is desired, the levels at which the circumferences are taken should be measured from some bony point. Thus, in measuring the thigh the writer prefers to take two points



FIG. 299.

Position of the adducted limb when the pelvis is brought straight (Bryant).

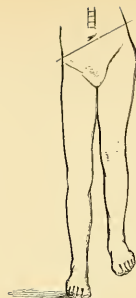


FIG. 300

Position of patient when standing with disease of the left hip-joint and an adducted limb. The pelvis is tilted up on the affected side, and the limb thereby apparently shortened (Bryant).



FIG. 301.

Abducted position of the diseased left limb when the pelvis has been brought into its natural position at right angles to the spine (Bryant).



FIG. 302.

Apparent elongation of the left lower extremity in hip disease on the left side, due to abduction of the limb and the necessary tilting upward of the pelvis on the sound side to allow of the abducted limb being brought into a line with the body (Bryant).

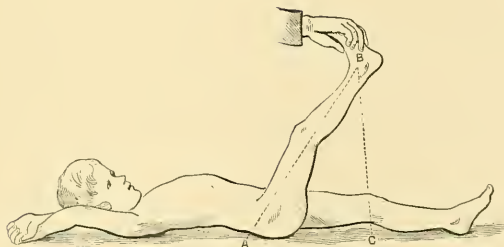


FIG. 303.

Method of Kingsley for estimation of flexion (Bradford and Lovett).

measured in the direction of the sartorius muscle from the internal condyle, three and five inches or five and seven inches, according to the size of the individual. The formula for a child would read:

Sound limb: R. thigh @ 3" = 14; @ 5" = 12. R. calf = 7
 Affected limb: L. thigh @ 3" = 13; @ 5" = 11. L. calf = 7

Such measurements are of great value for future reference. The calf measurement should be taken through its thickest part. Atrophy is seldom absent where hip disease exists.

Lameness.—A limp in the gait is one of the earliest objective signs of hip disease, but since it is intermittent in the earliest stage, and may be exactly simulated by other conditions, as a single positive sign it is of little value.

Later, the attitude and fixation of the limb, and shortening, induce an attitude and gait that are very characteristic.

Attitude of Limb.—The abnormal position of the thigh to the pelvis and to the opposite thigh are due in the early stages to muscular contraction; in the later stages to fibrous or bony ankylosis. Adduction and abduction are recognized by the patient, not as lateral deviations of the thigh, but as apparent shortening or lengthening of the affected limb.

In adduction the pelvis is tilted upward on the affected side, giving rise to apparent shortening of the limb; and in abduction the pelvis is tilted downward on the affected side, giving rise to apparent lengthening. This lateral tilting of the pelvis may be recognized by drawing an imaginary line between the anterior superior spinous processes, which should intersect at right angles a line drawn from the umbilicus to the pubis, if the pelvis is in its normal position. This apparent or practical shortening and lengthening, the result of adduction and abduction respectively, have led to some confusion which will require explanation. The accompanying diagrams (Figs. 299 and 302) will illustrate this.

This obliquity of the pelvis depends upon the fact that in walking or standing the limbs must be made parallel.

If, however (as in Fig. 299), the thigh is fixed by muscular spasm or ankylosis in an adducted position, progression is impossible while the affected limb crosses the sound limb. Elevation of the pelvis (as in Fig. 300) brings the thighs parallel and permits of walking, but the affected limb is apparently shortened in proportion to the degree of adduction present.

In the same manner, if (as shown in Fig. 301) the thigh be abducted, progression is impossible while the limbs are so widely separated. Lowering

of the pelvis (as shown in Fig. 302) brings the thighs parallel, but the affected limb is apparently lengthened in proportion to the degree of abduction present.

The position recommended as best suited for examination is that in which the sound and affected limbs are parallel; the nature and amount of the obliquity of the pelvis as it affects the diseased side is then more evident than when the pelvis and sound side are perfectly straight. For measurement of the apparent and practical shortening or lengthening, the position best suited is that in which the trunk and the sound side are perfectly straight. The practical measurements are then made with an ordinary tape-measure from the umbilicus to each malleolus. Thus, in adduction the tilting of the pelvis has caused a practical shortening of the affected limb, and in abduction the opposite tilting of the pelvis has caused a practical lengthening of the diseased member.

Real or bone shortening results from destruction of bone from disease or retarded growth, and is a permanent condition. It is best estimated by measuring from the anterior superior spinous process to the malleolus on each side. Real shortening is sometimes due to spontaneous dislocation from disease. In such cases the degree of subluxation, or the amount of change in the acetabulum, may be estimated by ascertaining the relation of the great trochanter to the Roser-Nélaton line. Thus, with the affected thigh slightly flexed, if a line be drawn from the anterior superior spinous process to the most prominent part of the tuberosity of the ischium, it should pass immediately above the upper border of the trochanter. If there is any alteration of this, luxation is evident, and its degree may be estimated.

The degree of adduction or abduction may be estimated with a goniometer, or joint measure. The horizontal arm is placed upon the anterior superior spinous process; the vertical arm is then placed parallel with the diseased limb, and the degree of deformity estimated. To estimate flexion or extension with the goniometer the instrument rests with the graduated arc against the body over the affected joint, with the horizontal arm in the line of the body. The movable arm rests against the limb parallel with its popliteal axis, while the index records the degree of deformity.

A simpler and more accurate method is that introduced and employed by Lovett, of Boston.* It is based upon the mathematic relationship existing between real and practical shortening. The measurements with the patient lying straight are taken in the usual way, with an ordinary tape-measure—

* "Boston Med. and Surg. Jour.," March 8, 1888.

i. e., the real or bone shortening is measured from the anterior superior spinous processes to each malleolus, and the apparent or practical shortening is measured from the umbilicus to each malleolus. An additional measurement between the spinous processes is necessary to complete the data. Upon these Lovett has constructed an elaborate table, and deduced the following rule: "If the practical shortening is greater than the real shortening, the diseased leg is adducted; if less than real shortening, it is abducted." For example: Length (from anterior superior spinous process) of right leg, 23 inches; left leg, $22\frac{1}{2}$ inches; length (from umbilicus) of right leg, 25 inches; left leg, 23 inches; real shortening $1\frac{1}{2}$ inches, apparent shortening 2 inches; difference between real and practical shortening, $1\frac{1}{2}$ inches; pelvic measurement, between spines 7 inches. By following the line $1\frac{1}{2}$ inches until it intersects the line for pelvic measurement of 7 inches, 22° is found to be the angle of deformity, and as the practical shortening is greater than the real, it is 12° of adduction of the left thigh.

Distance in inches between anterior superior spines.

	3	3½	4	4½	5	5½	6	6½	7	7½	8½	9	9½	10	11	12	13
¼	5°	4°	4°	3°	3°	2°	2°	2°	2°	2°	2°	2°	1°	1°	1°	1°	1°
½	10	8	7	6	5	5	4	4	4	4	4	4	3	3	3	3	2
¾	14	12	11	10	8	8	7	7	6	6	5	5	4	4	4	3	3
1	19	17	14	13	11	10	9	9	8	7	7	6	6	6	5	5	4
1¼	25	21	18	16	14	13	12	11	10	9	8	8	7	7	7	6	6
1½	30	25	22	19	17	15	14	13	12	12	10	10	9	9	8	7	7
1¾	36	30	26	23	20	18	17	15	14	13	12	11	10	10	9	8	8
2	42	35	30	26	23	21	19	18	16	15	14	13	12	12	10	10	9
2¼		40	34	30	26	24	21	20	19	17	16	15	14	14	13	12	11
2½			39	34	29	27	24	22	21	19	18	17	16	15	14	13	12
2¾				38	32	29	27	25	23	21	20	19	18	17	16	14	13
3				42	35	32	29	27	25	23	22	21	19	18	18	16	14
3¼					39	36	32	30	27	26	25	22	21	20	19	17	15
3½						40	35	33	30	28	26	24	23	22	21	19	17
3¾							38	35	32	30	28	26	25	23	22	20	18
4								42	38	35	32	30	28	26	25	23	21

The amount of flexion in degrees may be estimated in a similar manner, after the method of Kingsley, of Boston.* The patient lies on his back upon a table or other hard flat surface, and the surgeon flexes the diseased leg by the heel until the lumbar vertebrae touch the table (Fig. 303), showing that the pelvis is in the normal position, and the angle (A B C) which the leg makes with the

* "Boston Med. and Surg. Jour.," July 5, 1883.

table is the angle of flexion of the thigh from the normal position. In this position the surgeon measures off two feet on the external aspect of the leg with a tape measure, one (the zero) end of which is held on the table, in the direction of the line of the leg (A B). From this point (B) one measures the perpendicular distance in inches to the table (C), and from the number of inches in this line (B C) can be ascertained in the table the degrees of flexion of the thigh from the normal position. For example, if the distance between the point on the leg and the table is 10 inches, 25 degrees flexion of the thigh are present.

Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
0.5	1	6.5	16	12.5	31	18.5	50
1.0	2	7.0	17	13.0	33	19.0	52
1.5	3	7.5	19	13.5	34	19.5	54
2.0	4	8.0	20	14.0	36	20.0	56
2.5	6	8.5	21	14.5	37	20.5	58
3.0	7	9.0	22	15.0	39	21.0	60
3.5	9	9.5	24	15.5	40	21.5	63
4.0	10	10.0	25	16.0	42	22.0	67
4.5	11	10.5	27	16.5	43	22.5	70
5.0	12	11.0	28	17.0	45	23.0	75
5.5	14	11.5	29	17.5	47	23.5	80
6.0	15	12.0	30	18.0	48	24.0	90

If the leg is so short that it is impracticable to measure off 24 inches, one may measure 12 inches; from this point ascertain the distance to the table in a perpendicular line just as before, double this distance, and look as before for the amount of flexion present.

Pain.—Pain may be absent in any or all the stages of hip disease, but the characteristic pain is usually experienced in the affected joint or in the corresponding knee. The latter is often intermittent, and usually signifies the femoral form of disease. Pain in the arthritic form is constant, acute, and accompanied with a feeling of tension and tenderness above the great trochanter. Tenderness and pain on jarring the hip or on motion are more marked in the acetabular variety. Pain elicited by striking on the knee or heel, and thus pressing the joint surfaces together, is untrustworthy, and as a diagnostic sign should be abandoned.

Swelling.—Local swelling is considered as one of the most important symptoms. It is most marked in the arthritic variety, which may be considered the acute form of the disease. Confined to the front and back of the joint, it indicates effusion into the synovial sac; confined to the great trochanter, it has been considered pathognomonic of suppuration within the joint. Thicken-

ing of the great trochanter as a late symptom is of some value as a confirmatory sign, but swelling and thickening alone are of but little importance.

In conclusion, the general diagnostic signs of hip-joint disease are limitation of motion, atrophy, lameness, attitude of limb, pain, and swelling; and of these, the first two are peculiarly significant of early disease, while later are added the attitude of the limb and swelling.

Differential Diagnosis.

Many diseases have been mistaken for hip disease through ignorance of its characteristic symptoms, or at a very early period of the disease. The diagnosis of contusions and sprains can readily be ascertained by exclusion, and of muscular rheumatism of the hip by the inherited or acquired history of the affection, the lameness preceding the pain, the absence of reflex muscular spasm, and local hyperesthesia, perinephritis, perityphlitis, rachitis, and pseudo-hypertrophy are entirely dissimilar, and do not require consideration.

Hip disease could only be mistaken for abscess external to the joint, for disease of the knee, or for caries of the great trochanter, by neglect of careful examination.

The diagnosis from separation of the upper epiphysis of the femur with abscess is difficult, if not impossible—a matter which, fortunately, is of no practical moment, as excision would be equally indicated in either affection. The same may be said of the differential diagnosis of traumatic, rheumatic, or blennorrhagic arthritis from the arthritic variety of morbus coxarius, since conservative treatment would be indicated in either affection.

There, are however, several affections commonly mistaken for hip disease which deserve thorough consideration. They are as follows:

1. Synovitis of the hip-joint.
2. Lumbar Pott's disease.
3. Periarthritis.
4. Infantile spinal paralysis.
5. Congenital dislocation.
6. Sacro-iliac disease.
7. Hysterical affections.

Synovitis of the Hip-joint.—The greatest difficulty will be experienced in distinguishing acute primary synovitis from the arthritic form of chronic articular osteitis. The acute nature of the affection, the short course, the absence of muscular spasm and atrophy, with eversion and outward rotation

of the limb, are all of value in distinguishing synovitis. The acute form may, however, become chronic, and a number of orthopedic surgeons still favor the possibility of a synovitis eventually becoming an osteitis. Of this nature undoubtedly is the so-called arthritic variety of hip disease. Of such nature are the cases with marked characteristic symptoms which recover promptly and permanently within a few months.

From synovitis the following considerations will be sufficient to establish the distinction:

SYNOVITIS.

1. Pain coincidental with lameness, and invasion sharp and clear.
2. Locomotion speedily impossible.
3. Occurs after eighth year.
4. Joint tenderness present.
5. No bone tenderness nor periarticular or articular infiltration.
6. Muscular atrophy absent.
7. Rotation, eversion, and apparent elongation.

CHRONIC ARTICULAR OSTEITIS.

1. Pain preceded by lameness, and invasion seldom if ever, sharply defined.
2. Locomotion continues possible.
3. Occurs before eighth year.
4. Joint tenderness absent.
5. Bone tenderness early; infiltration beginning of second stage.
6. Muscular atrophy present.
7. Limbs parallel in early stage.

Lumbar Pott's Disease.—In the early stage of lumbar Pott's disease it is difficult and in some instances almost impossible to arrive at a positive diagnosis from hip disease until the symptoms become more thoroughly established. Among the first symptoms may be a limp and limitation of motion in one limb from irritation or the presence of pus in the psoas muscle. This limitation of motion is confined usually to forced extension, but later, from extension of the pus as a psoas abscess, limitation of all motion at the hip will still further complicate the diagnosis. In either event the presence of muscular spinal rigidity from reflex spasm will determine the true nature of the affection, due allowance being made for the spasmodic contraction upon manipulation of these muscles in hip disease. The amount of abduction present in the hip-joint is also important, since abduction is very early lost in hip-joint disease, while it often remains free in advanced cases of psoas irritation and contraction. In advanced cases of lumbar Pott's disease, where psoas abscess is in contact with and irritates the hip-joint, it is extremely difficult to ascertain whether or not hip-joint disease coexists. The amount of abduction and rotation present, and the effect of rest and quiet to the joint, will best determine the exact condition. In conclusion, in lumbar Pott's disease the following peculiarities will be of service in arriving at a correct diagnosis: The lameness is subject to complete remissions, depends upon psoas contraction, and has more lordosis associated; the patient can stand as well upon the lame limb as upon the

other, and reflex muscular spasm is never excited by passive motion of the lame hip. Moreover, the pain and stiffness are usually present in the morning in lumbar Pott's disease and pass away during the day, whereas in hip disease they are absent in the morning and more marked toward the close of the day.

Periarthritis.—It is only in the very early stage and only in phlegmonous inflammations about the joint that much difficulty is experienced, since the fibrous form does not, as a rule, occur in children. Under this head may be included inflammation of bursal and lymphatic glands and psoas abscess. The acuteness of the attack, the history of traumatism, the rapid development of the physical signs of acute abscess, the constitutional disturbance, the absence of reflex muscular spasm and atrophy, and the osteitic "night-cry," would serve to distinguish periarthritis.

The movements of the muscles, whose mechanical execution is interfered with by inflammation, is limited, but the reflex element is absent, as likewise it is in cases of sarcoma of the hip, in which the greater hardness of the swelling, as well as the absence of the typical symptoms, would distinguish it.

Infantile Spinal Paralysis.—In the initial stage of infantile spinal paralysis, the age, tottering walk, history of fall, accentuation of pains, and hyperesthesia of the joint closely correspond to early hip disease. Later, the absence of pain and swelling, the abnormal mobility, the extreme atrophy of the whole limb, and coldness render the diagnosis patent. Acute hip disease may, however, occur in a leg affected by infantile paralysis. The differential points which establish the diagnosis in infantile spinal paralysis are: the character of the walk, which is a tottering, not a stiff gait; the absence of reflex muscular spasm and abscess; the degeneration reactions given with the galvanic current, the normal formula of CCC > ACC being reversed (*vide* Infantile Spinal Paralysis); and the loss of the faradic reaction within the first week, an important and easy diagnostic point for the general practitioner.

Congenital Dislocation.—The persistent limp and the pain of sprains from repeated falls are the only symptoms in congenital dislocation which have any resemblance to hip-joint disease, but the congenital nature of the limp, the excessive mobility of the joint, the entire absence of reflex muscular spasm or limitation of motion, and, in fact, of all the important symptoms of the latter disease, lead to its easy recognition. With the aid of a skiagraph the differential diagnosis can readily be made. In congenital dislocation the displacement of the head of the femur will be observed with a perfect contour

of the articulating surfaces, whereas in hip-joint disease, even if so-called dislocation has occurred, the erosion or destruction of the part of the head will be noticed. Moreover, congenital luxation is more frequently bilateral than is hip disease.

Sacro-iliac Disease.—This affection imitates hip-joint disease in the lameness, pain when the joint surfaces are pressed together, elongation of the limb, and often in the presence of abscesses. It differs from hip disease in that the seat of greatest tenderness is different, the limb is not abducted, there is no shortening, and no pain on moving the hip if the pelvis be fixed, nor from pressure on the trochanter and counter-pressure on the tuber ischii; the patient inclines the body to the opposite side and not forward in walking, and the pelvic distortion is permanent and absolute, and not, as in hip disease, temporary and relative. The skiagraph will be of great service in differentiating hip-joint disease from sacro-iliac disease, the tubercular lesion being distinctly noted in either case.

Hysteric Affections.—Functional joint disease of the hip occurring in young anemic women, particularly of the upper class, coincides closely with the *bona fide* organic disease. As *coxalgie hystérique* it is exceptionally rare in men, Charcot having observed but one case in the Salpêtrière. Pain, which is so exquisite as to resent the slightest contact, is localized in the region of Poupert's ligament, over the sacrum, or in the lower part of the thorax. The limb, rigidly fixed during any manipulation, relaxes under gentle pressure when the attention is withdrawn or the examination completed; the nutrition of the limb is intact; there is no trace of muscular atrophy. The greatest difficulty is experienced where the neurotic element exaggerates a true arthropathy. In such, a true estimate can only be made by the discovery that the symptoms are out of all proportion to the objective signs. A correct diagnosis may be made by observing the presence of an inherited or acquired neurotic diathesis; the simultaneous appearance of pain and lameness; the correspondence of the areas of hyperesthesia and paresthesia to the distribution of certain nerve-branches; the yielding readily to forced movements of the muscular spasm about the joint, and the effect of anti-neurotic medication upon the disease. In the later stage anesthesia will be an important aid, since the muscular rigidity of the neuro-mimetic coxalgia will disappear under its administration, while the permanent contraction of hip-joint disease will remain. If any doubt exists after the administration of the anesthetic, a skiagraph would be of great service in rendering the diagnosis positive.

Prognosis.

Hip disease tends to recovery, with more or less deformity in the majority of cases, the prognosis in individual cases being directly influenced by the age of the patient, the variety of the disease, the association of complications, and the efficiency of treatment. The prognosis is likewise affected by the hygienic surroundings and social status of the patient, the mortality being much higher in dispensary and hospital than in private cases. When the disease makes its appearance after puberty, it is less manageable, more extensive, and more often fatal than when it occurs at an earlier period.

In the arthritic variety of the affection the prognosis is most favorable, being more serious in the femoral, and still more grave in the acetabular variety. The coexistence of some grave organic disease of an internal organ, as nephritis, phthisis, tubercular meningitis, or caries of some other portion of the skeleton, as the vertebrae, renders the prognosis most unfavorable.

In a like manner does efficient treatment, early commenced, favorably influence the subsequent course and termination of the disease. Spontaneous recovery of extremely severe cases sometimes occurs, but the early employment of proper and efficient treatment will prevent complications and otherwise directly and favorably influence the prognosis in all cases.

The prognosis will differ in the different varieties. In the acute tubercular form the prognosis is not so favorable as in the chronic ulcerative, the disease being much more rapid and acute in the former, and the mortality higher. In the second or chronic ulcerative form the prognosis is most satisfactory under efficient treatment, unless there are complications. In the third or chronic tubercular form the disease is less acute and the prognosis is less favorable than in the second group, but more favorable than in the first group.

Under prognosis the results of efficient treatment, relapses, the causes of death, the time required for treatment, the prognosis in double hip disease, and the effect of operation upon the prognosis, must all be considered.

Efficient Treatment.—The mortality in all cases which have been under treatment varies from 7 per cent. to 73.2 per cent., the increased mortality in all cases being directly influenced by the absence or presence of suppuration and complications. The mortality is greater in hospital than in private practice, and it also appears to be higher in Germany than in this country. In my own statistics there were 13 deaths in 421 cases. Thus, in the Alexandra Hospital, London, there were 100 deaths in 384 cases, a mortality of 26 per cent.; of these, 260 were suppurating cases, among which the mortality was 33.5 per cent.;

whereas in the Clinical Society's Report, in 1880, the mortality reached 30.4 per cent. in the suppurating, and about 7 per cent. in the non-suppurating.

Cazin reports that in 80 suppurative cases treated at the hospital in Berck, France, 12 per cent. died.

Gibney reports that in 288 cases, 48 of which had abscesses, 12½ per cent. died.

Jacobson records 73.2 per cent. of deaths out of 63 suppurating cases that were treated without operation.

Wright found that in 100 cases treated without operation, only 35 of which could be traced as to sequel, 9 were unrelieved or relapsed, and 9 died, or 25.2 per cent.

In the more recent reports the mortality was as follows:

Mummelthy, of Kiel, reports 48.59 per cent. in non-operative cases and 53.96 per cent. in operative cases.

Marsch, of Marburg, reports 35 per cent. in non-operative, and 40.4 per cent. in operative cases.

Huismans, of Heidelberg, reports 46.6 per cent. in non-operative cases and 58 per cent. in operative cases.

Pedolin, of Zurich, reports 37.7 per cent. in non-operative cases and 54 per cent. in operative cases.

The death-rate from hip disease is small in private practice. Thus, Sayre in 212 cases had only 5 deaths, Lorenz in 60 cases only 3 deaths, and Taylor in 94 cases, 24 of which were suppurative, had only 3 deaths.

The mortality in all cases of chronic arthritis of the hip-joint may be said to range between 7 per cent. and 30 per cent.

Relapse.—The frequency of relapse is also shown in these statistics, there being 9 unrelieved or relapsed in 35 cases treated by Wright, and 6 relapsed in the 51 cured cases investigated by Shaffer and Lovett. Relapses result from the infliction of fresh injury, the too early use of the limb, or are induced by the failure of the health from intercurrent disease, as scarlet fever, measles, etc., and consequently influence the prognosis. In such cases it is important to distinguish between true *relapse* and a *residual abscess*, the latter being the result of irritation of some local product of former disease, with little tendency to spread, the former demonstrating a lack of sound repair in the original lesion and tending to progress, as in the first instance.

The reports of the results of conservative treatment would tend to emphasize the importance of the influence of treatment upon the prognosis in this disease.

In the 80 cases treated by Gibney* by internal medication and counter-irritation alone, at the end of the disease—which ran its course in 33 cases in three years, in 28 cases in from three to six years, and in 19 cases in from six to ten years—61 of the patients could walk well, and run without discomfort; 12 walked only fairly, requiring a support at times, and 7 could not walk without crutches. In these 80 cases, 12 had, at least, an arc of 15 degrees motion in the diseased joint, the shortening amounting, in the majority of cases, to from one to three inches. Abscesses had existed in 48 cases.

In a more recent series of cases reported by Gibney† in 107 cured cases treated by mechanical and operative methods, the following results were shown:

No flexion,.....	47
Flexion of 10 degrees,.....	30
Flexion of 10 to 20 degrees,.....	20
Flexion of 20 to 30 degrees,.....	10
Perfect motion retained,.....	13
Good motion retained,.....	22
Limited motion retained,.....	41
Ankylosis in,.....	31

Of the 41 cases who remained well of the 51 cases recorded by Shaffer and Lovett, none were incapacitated from doing a full day's work at his or her trade or occupation, and only one, a boy, who had suffered from associated Pott's disease, used a cane.

In the 76 cases more recently reported by Mr. Howard Marsh,‡ the favorable results of conservative mechanical (fixation) treatment are well shown. Of 37 suppurative cases one year after discharge, recoveries were perfect in 1, excellent in 6, good in 17, and moderate in 13. In 39 non-suppurative cases recoveries were perfect in 9, excellent in 9, good in 12, and moderate in 9. The average amount of shortening was two-thirds of an inch, while 50 per cent. had a degree of movement in the affected joint classed as "free movement."

Causes of Death.—Death in hip disease may occur from the general dissemination of tuberculosis, as in tubercular meningitis, phthisis pulmonalis, or general miliary tuberculosis; from lardaceous disease of internal viscera; from pyemia and septicemia; from exhaustion from suppuration; from intercurrent disease, as measles, scarlatina, etc.; and from operation. The mortality

* "N. Y. Med. Rec.," March 2, 1878.

† Gibney, Waterman, and Reynolds: "Transactions Amer. Orth. Assoc.," 1898, vol. xi.

‡ "British Medical Journal," August 3, 1889.

is increased by suppuration; thus, in the statistics collected by Bruns the mortality in the suppurative cases was 52 per cent., and in the non-suppurative cases 23 per cent. Of the 614 cases recently analyzed at the Alexandra Hospital, there were 35 deaths, as follows: meningitis, 12; disease of the lungs, 5; amyloid disease, 9; following amputation, 3; exhaustion, 2; uncertain, 4. Of the 96 deaths after suppurative hip disease at the same hospital, there were from meningitis, 16.7 per cent.; albuminuria and dropsy, 20.8 per cent.; phthisis, 5.2 per cent.; phthisis and albuminuria, 3.1 per cent.; exhaustion, 9.4 per cent.; erysipelas and pyemia, 3.1 per cent.; intercurrent disease, 7.3 per cent.; and after operation, 9.4 per cent.; unknown, 25.0 per cent. In the Clinical Society's report, 1881, in 260 cases with suppuration treated without excision, 30.4 per cent. died from causes connected with the disease, of which 9.2 per cent. died from tubercular disease; and in 124 cases without suppuration treated without excision, the total mortality was 10.5 per cent., of which 7 per cent. died of tuberculosis. In the same report of Mr. Croft's 45 cases of excision, 7 cases died from results of operation, and in Mr. Bryant's and Mr. Baker's 203 cases of excision, 13.7 per cent. died directly from the operation.

In a report of 778 patients suffering from hip disease in the New York Orthopedic Dispensary there were 50 deaths, the causes of which were as follows:

Tuberculous meningitis,.....	20
Amyloid degeneration,.....	5
Phthisis,.....	3
Exhaustion,.....	3
Tuberculous peritonitis,.....	1
Sepsis,.....	1
Convulsions,.....	1
Unknown,.....	16

Time Required for Treatment.—Cases of hip disease under thorough and efficient conservative treatment will require from two to four years permanently to establish a cure, and without mechanical treatment the disease will run its course in from three to ten years.

Thus, in the 39 cured cases reported by Shaffer and Lovett, 31 required from two to four years to effect a cure, and the remaining 8 from four and a half to eight years.

In the 80 cured cases reported by Gibney, 33 ran their course in three years, 28 in from three to six years, and 19 in from six to ten years. Even after all the signs have disappeared, it is better for a time to continue the use of the splint, or to substitute a convalescent splint in order to avoid relapse.

Amount of Deformity.—Mild cases may recover with perfectly free motion and without either deformity or shortening (Figs. 304-306); but where suppuration has occurred, and particularly in the femoral and arthritic varieties, unless persistent precautions have been taken with regard to position, ankylosis with great deformity will ensue. If ankylosis occur, the position of the limb as regards locomotion is most important. Obviously the less the flexion and abduction, the more favorable the position. Even severe grades of distortion may, however, subsequently be entirely removed by osteotomy.

A perfect recovery from hip disease would be shown by the patient being able to take certain positions as well with the cured limb as with the limb which



FIG. 304.



FIG. 305.



FIG. 306.

Author's cured case of disease of the right hip-joint, one-fourth inch shortening, showing: Fig. 304, extension; Fig. 305, flexion; and Fig. 306, rotation of joint.

had not been diseased. The first one is the best standing position, the second forced flexion in the standing position, and the third standing on one limb and flexing the limb across the other one. These tests are well shown in the accompanying figures (Figs. 307-315).

In all cases where suppuration has occurred, shortening to a greater or less degree is the rule. The degree of ultimate shortening will depend upon the position of the limb, dislocation true or false, actual destruction of osseous tissue by disease or operation, and arrest of growth. The amount of shortening increases slightly subsequently from permanent retardation of growth.

By massage and exercise muscular atrophy may be diminished but never entirely disappears. The appearance of abscess is significant either of inefficient

treatment or of the advancement of the disease in spite of thorough treatment. In the former event it demands greater care and vigilance, in the latter it betokens a serious prognosis and a high mortality.

Treatment.

The treatment of hip-joint disease has in later years received much attention and been greatly modified. From the time when the remedies employed were entirely of a constitutional nature, little attention being given to local measures, to the present time, when complicated mechanical appliances are employed to the complete exclusion of local remedies, many decided advantages have been secured and many important principles have been established.

In conjunction with the employment of mechanical means the writer would urge the importance, as adjuvants to a speedy cure, of improved hygiene, generous diet, sufficient sleep, and such constitutional medication as the general condition of the afflicted individual may indicate. In some instances counter-irritation and local applications may be required to meet certain indications.

Local treatment in hip disease may be divided into:

1. Conservative or mechanical, and
2. Operative or surgical.

The conservative or mechanical method aims to put the inflamed joint at rest by recumbency with traction, by fixation, or by traction, the latter two being especially employed as portative appliances.

Recumbency with extension is a well-recognized plan of treatment, and one employed at times to meet certain conditions by those who most valiantly support locomotion with portative apparatus. This may be accomplished by means of the Buck extension, the so-called "stretcher splint," or "extension tray," the *gouttière de Bonnet* or wire cuirass, and the "portable bed."

The "Buck extension" is employed as in the treatment of fractures of the femur and as described in all systematic works upon general surgery. To secure counter-extension by means of the body-weight the foot of the bed should be elevated. From one-half to two bricks or an equivalent weight should be employed to make extension. A more elegant extension, known commonly as the "Sayre extension," may be applied by cutting the plaster as for the long traction splint. Two strips of adhesive plaster the length of the entire limb, about four or five inches wide at the upper end, and one-third the width at the lower, are prepared by cutting the plaster into five tails. From the upper end of the center tail a piece four to six inches long is cut and added to the



FIG. 307.—FIRST TEST POSITION, AFFECTED HIP.



FIG. 308.—SECOND TEST POSITION, AFFECTED HIP.



FIG. 311.—FIRST TEST POSITION, UNAFFECTED HIP.



FIG. 312.—SECOND TEST POSITION, UNAFFECTED HIP.



FIG. 309.—THIRD TEST POSITION, AFFECTED HIP.



FIG. 310.—FOURTH TEST POSITION, AFFECTED HIP.



FIG. 313.—THIRD TEST POSITION, UNAFFECTED HIP



FIG. 314.—FOURTH TEST POSITION, UNAFFECTED HIP.

lower end to reinforce it. The two applied ends are folded upon themselves and buckles attached, and the whole, thus prepared, are applied to the lateral aspect of the leg, the buckles immediately above the malleoli and the center tails extending the entire length of the limb. The lower tails are wound spirally about the leg, overlapping each other, the other two pairs are wound spirally about the thigh, and the whole is secured by a spiral reversed roller bandage extending from the ankle to the perineum. Extension from the buckles is made with a steel bar about six inches in length, perforated in the middle for the extension cord, and having the leather straps extending from either extremity. The advantage of such an apparatus is the ease with which a long traction splint may be applied at one time and extension at another.

The stretcher splint or extension tray consists of an oblong frame made of bar iron one-fourth by one inch for small children, one-fourth by one and one-fourth inches for older children, and shellacked, varnished, or galvanized to prevent rusting. The frame is then covered with canvas, except a two- or three-inch space in the center corresponding to the anal opening, tightly laced on the under side. Traction is made with adhesive strips in the usual way, the cord from the center of the stirrup passing over a wheel attached to an upright steel piece slid on the lower end of the frame, so arranged that the wheel may be elevated or lowered to make extension in the line of the deformity. Counter-extension is made by two perineal straps attached to the frame or to an arm arching over the hips from the affected side and firmly secured to the side bar of the stretcher. These straps pass through the central opening and upward, to be attached to the stretcher. Shoulder-straps to prevent rising may be added, but are seldom required. Upon this stretcher or extension bed the child may be carried from place to place.

The *gouttière de Bonnet* or wire cuirass fulfils the same indications—recumbency and extension—but is more expensive. The portable bed, as constructed by Phelps, possesses all the excellent qualities of the wire cuirass, and has the advantage of cheapness, being a plaster and wooden cuirass which any practitioner may readily construct. A board of three-quarters of an inch spruce is cut to correspond to the shape of the child, four inches longer and three-quarters of an inch wider than the patient. The child is then laid upon the board and enveloped with a plaster-of-Paris bandage from the feet to the axilla to a thickness of three-eighths of an inch. As the plaster bandages are rolled on they should be nailed to the edges of the board, thus making the board and plaster one. When the plaster is set, the front is cut away. The bed is

then lined, a front put on, and lacings put in, or the child can be held in place by bandages. Extension is made to the foot-piece.

This furnishes a cheap and excellent mode of treatment, particularly in the more acute stages of the disease, and in it the child may be readily carried about without the possibility of injury to the affected part.

The Fixation Method.—**Fixation**, as a principle in the management of hip-joint disease, enters into the methods of treatment before described, but as an element in the employment of portable splints it deserves further notice. Fixation without extension is the principle of the fixation or so-called English method, to distinguish it from splints constructed on the principle of extension, or the so-called American method.

They are all constructed upon a combination of the physiologic and fixative methods, and aim to immobilize the hip-joint by plaster-of-Paris bandages, leather or metal splints applied to the hip, pelvis, and thigh, and the use of crutches and a patten. A plaster-of-Paris bandage may be applied from the ankle of the affected limb up to the axilla, encircling the limb, pelvis, and thorax. As a temporary measure it has advantages, particularly if applied under ether for the correction of deformity, but as a permanent dressing it is clumsy and uncleanly. Moreover, it does not firmly fix the trunk above the pelvis, the possible motion of the lumbar vertebrae interfering with the fixation of the hip-joint through the movement of the pelvis. Moreover, it has no effect upon reflex muscular contraction and the coincident intra-articular pressure, since no traction is applied, and consequently will not prevent the destruction of the head of the femur and perforation of the acetabulum from absorption. The usual deformities peculiar to the disease may be prevented.

The same remarks apply to the fixation leather and metal splints, which, not extending so high in the thorax or so low in the limb, do not fix the joint so well as the plaster dressing. They fulfil certain indications, however, and in some cases accomplish good results, but as a mode of treatment to the exclusion of others they are not to be recommended. A very ingenious fixation splint is the one devised by Willard. It is made of enameled leather over a cast, and has a simple joint over the articulation so that the patient can sit down with comfort. It is always used in connection with crutches and a high shoe, and is applicable to a limited number of cases—those in which the inflammatory symptoms are not acute.

The most perfect type of a pure fixation splint is that of Thomas, which, in his hands, was undoubtedly an efficient apparatus, as almost any apparatus

might become, considering the skill, accuracy, and thoroughness with which it was applied.

It is simple in construction, and can be readily made by the practitioner. It consists of a malleable iron bar extending from the lower angle of the scapula to the lower third of the leg—just where the calf begins. This should be one inch by one-quarter inch for an adult, and three-quarters by three-sixteenths for children. Three strips of hoop iron, one (the chest crescent) for the upper extremity, four inches less than the circumference of the thorax, attached at right angles to the upright; one (the thigh crescent) for the thigh, two-thirds the circumference of the thigh at its upper third; another (the calf cres-

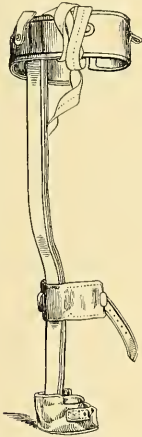


FIG. 315.—THOMAS HIP SPLINT.

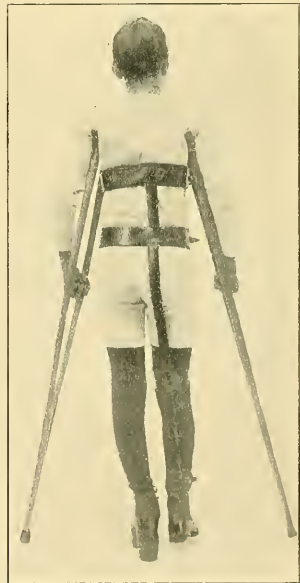


FIG. 316.—THOMAS HIP SPLINT APPLIED.

cent) for the calf, one-half the circumference of the limb at this point. The splint, fitted to the posterior part of the trunk and affected limb, is held in position by a strap and buckle attached to the upper band; suspenders are used over the shoulders, and a roller bandage firmly applied to the lumbar portion and the limb. A patten is worn on the sound side, high enough to clear the foot of the diseased limb, and crutches are employed.

Its proper application requires skill, and its inventor deserves credit for the great attention to detail exhibited in describing the splint. This method

of treatment has much to recommend it to the profession in general, particularly in hospital cases and where patients cannot secure sufficient personal attention to employ a traction splint. Under these conditions better results are attained by fixation methods than by traction appliances improperly used.

As a fixation splint in recumbent cases *with traction* it is an excellent appliance. For the correction of deformity the upright is bent at the buttock, and the splint is applied in the deformed position, the curve of the upright being lessened as the deformity yields. While the fixation of the Thomas splint is not perfect, the principal objection is that there is no traction to prevent intra-articular pressure from reflex muscular contraction. My own observation leads me to believe that abscesses are more frequent, and this impression is confirmed by comparison of the report of 62 cases of hip disease observed in the practice of Thomas, of Liverpool, by Ridlon, of 58 of which 23 had one or more abscesses, or 39.6 per cent., and the results of a series of 63 cases from the Boston Children's Hospital, in which abscesses occurred in only 23 per cent. of all cases of hip disease under out-patient treatment. Since these reports represent the best results of both the fixation and traction methods of treatment in the hands of surgeons of equal skill, under similar conditions, the comparison may be considered just and the result obvious.

When supplemented by bed traction during the first part of the treatment, and by bed traction at night during the subsequent part of the disease, it forms a satisfactory form of treatment in hospital cases.

Fixation versus Ankylosis.—The dread of ankylosis, according to Verneuil, has led to much bad surgical practice, but recent experiments and discussions have clearly established the dictum of Gibney, "that whatever ankylosis occurs in a joint subjected to immobilization, occurs by reason not of the immobilization, but of the nature and intensity of the inflammations and of the inefficiency of the apparatus employed."

Perfect immobilization, or absolute fixation, is almost an impossibility by fixation apparatus alone. False ankylosis is due to contraction of the peri-articular muscles from reflex irritative spasm. Fixation by means of traction applied early will relieve muscular spasm, prevent trauma of the articular surfaces, diminish intra-articular pressure, and permit a subsidence of the inflammation, after which either motion or fixation may occur in the joint, since ankylosis, if it occurs, depends directly upon the amount of disease, and not upon either fixation or traction.

Phelps, in a series of carefully conducted experiments upon dogs, concludes:

(1) That a normal joint will not become ankylosed by simply immobilizing it for five months. (2) That motion is not necessary to preserve the normal histologic character of a joint. (3) That when a healthy joint becomes ankylosed or its natural histologic character changed, it is not due to prolonged rest, but to pathologic causes. (4) That immobilization of a joint in such a manner as to produce and continue intra-articular pressure will result in destruction of the head of the bone and the socket against which it presses. (5) That atrophy of the muscles of the limb will follow prolonged immobilization of a joint.

If, as he remarks, these experiments prove that prolonged fixation will not produce ankylosis of a natural joint, that motion is not essential for the preservation of its normal function, then the causes of ankylosis must depend upon pathologic conditions, and not upon prolonged fixation.

These experiments are valuable as illustrating the effect of prolonged

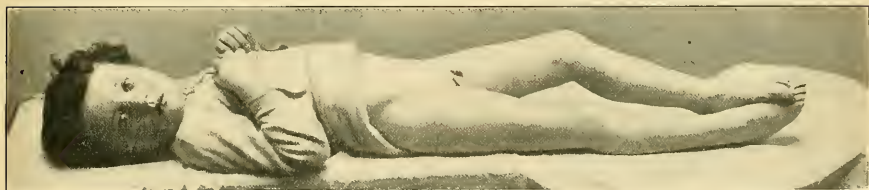


FIG. 317.—INSTINCTIVE EFFORT AT TRACTION IN HIP DISEASE.

fixation in healthy joints. They do not solve the problem of the control of reflex muscular spasm, the most destructive element in the disease. Traction, with or without fixation, will best control this muscular spasm, diminish intra-articular pressure, secure rest, and diminish inflammation.

Traction by extension and counter-extension is the keynote of correct surgical treatment in hip-joint disease.

The Traction Method.—It is upon this principle of traction in the line of deformity that the long extension splint, or the so-called, by Europeans, American method of treatment for hip-joint disease, is established. To relax the muscles by overcoming the muscular spasm, and to induce fixation and prevent concussion, are the objects sought. It would appear from recent experiments that a distracting force sufficient to separate the head of the bone from the acetabulum is neither necessary nor desirable. Experiments upon the cadaver are unreliable, since reflex muscular spasm, the most important

factor, is absent. König and Paschen, upon the cadaver, found slight separation, using eight pounds or more; while Morosoff was unable to separate the surfaces with less than sixty pounds. Lannelongue, however, by frozen sections found ten pounds sufficient to produce separation in a well-marked case of hip disease. (For a thorough *résumé* of the subject of distraction, *vide* "An Experimental Study of Distraction of the Hip-joint," by E. G. Brackett, "Trans. Amer. Orthop. Assoc.," vol. ii, p. 207; also Judson, "Growth and Deformity," 1905, p. 88.) Upon anatomic grounds a much less weight is known to be required to produce distraction if the limb be abducted, since when the limb is in the line of the body, or adducted, the cotyloid ligament surrounding the head renders separation almost impossible.



FIG. 318.—TAYLOR HIP SPLINT.

Lovett, estimated from an experiment upon a healthy boy of ten years that the thigh muscles are capable of exerting a force of thirty-six pounds. It is highly probable that separation of joint surfaces in hip disease is seldom or never attained, but that the traction force employed for a long time overcomes the muscular spasm, secures fixation and rest to the affected part. The amount of fixation at the hip-joint secured by the long traction splint has been variously estimated, but the only experiments of any practical value are those of Lovett, before referred to. Traction will best fix the joint and fulfil the indications in the acute forms of disease when the joint between the upright and pelvic band is fixed

by a screw or strap of webbing which will permit or arrest motion, and where two perineal straps are employed.

Traction Splints.—All long traction splints at present in use are patterned more or less after Taylor's modification of Davis' splint, being commonly described as the "Taylor splint," the "Sayre long splint," or the "long traction splint." The principles of the so-called mechanical treatment are founded upon the two following aphorisms:* "(1) All organs while in a state of disease

* Taylor: "Boston Med. and Surg. Jour.," March 6, 1879.

require rest from the performance of their functions in the direct ratio of the amount, quality, and intensity of the abnormal movements. (2) What is rest for an organ in one condition is not necessarily rest for it in another condition; that is to say, an organ in a certain degree of progressive inflammation presents conditions essentially different from the same organ in the same relative degree of inflammation in the retrogressive stage."

The first object sought is to overcome the muscular contraction by extension and counter-extension applied to the line of the deformity. This is accomplished by means of a long steel bar extending from the trochanter to below the foot, to which above is rigidly attached a sheet-steel pelvic girdle and one or two perineal bands, and which below is attached to the limb by adhesive plaster straps or bandages. To more readily adjust the appliance to varying lengths of legs, as well as to apply extension, the long steel bar is provided with a tube and sliding ratched bar moved by a key and secured by a spring and sliding catch. The lower part of such a splint, bent at right angles to the long upright bar, is covered with a flat leather or rubber shoddy shoe, and has attached a leather strap for attachment to the buckles upon the adhesive appliance on the leg. The pelvic band may be rigidly attached to the long bar, but is best secured by a bolted screw, which will permit motion or fixation. The perineal straps may be made of military webbing covered with leather, canton flannel, silk, or chamois. Pads are objectionable, straps being more comfortable and less likely to chafe or excoriate. With ordinary care as to cleanliness and the local application of alum and alcohol, two drams to the pint, followed by dusting with talcum or ordinary toilet powder, little difficulty will be experienced, and any reasonable amount of pressure may be made upon the perineum. Should the parts chafe or excoriate, acetanilid in unguentum aqua rosa or vaselin will relieve, or, failing in that, the splint may be removed for a few days and the patient be confined to bed, traction being applied by a cotton roller or stocking.

The long bar may be variously modified to meet indications. The upper

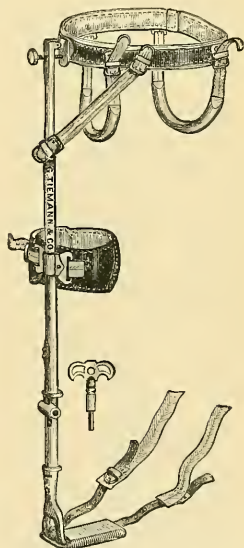


FIG. 319.—TRACTION SPLINT FOR THE LEFT LEG, SEEN FROM THE BACK, PROVIDED WITH TWO PERINEAL BANDS AND AN ABDUCTION SCREW (Bradford and Lovett).

portion may be attached by two portions for convenience in dressing sinuses; it may have attachments to secure the knee laterally, or antero-posteriorly, as the U-shaped attachment of Judson, for the purpose of better fixation of the thigh; or it may be made stronger or less flexible, as in the Judson brace, and so twisted upon itself and tapered that the weight is centered near the upper part. The traction straps applied for the extending force should extend beyond the knee and well up the thigh to avoid undue traction upon the lateral ligaments of the knee. Strong surgeon's adhesive plaster is efficient. Maw's moleskin

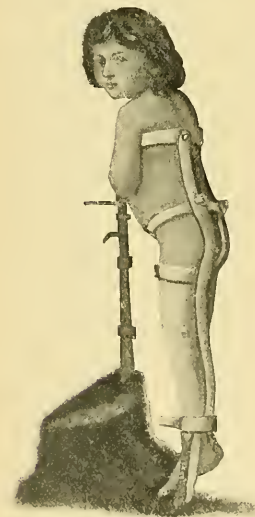


FIG. 320.—COMBINED FIXATION AND TRACTION SPLINT (Lovett). (By permission of the Trustees of the Fiske Prize Fund.)

plaster, made in England, is the best, but Shivers's swan's-down plaster, made in Philadelphia, answers equally well. They should be changed about every four weeks, but, no irritation or displacement ensuing, they may remain on from three to four months. If chafing occurs beneath the dressing, the parts should be dusted lightly with powdered boric acid when being renewed. Substitutes for plaster where the skin is extremely sensitive, such as a cloth or leather legging, or a stocking extension, may be employed, but all are inferior.

The plaster should be cut as before described, and the roller

bandage applied to retain them should be over-seamed its entire length, or, better, be secured by a narrow strip of adhesive plaster wound spirally up the leg and thigh. In applying the splint the pelvic band and perineal straps should first be secured, next the foot-piece be attached by the straps to the buckles; extension is then to be made, and finally the knee is to be secured. Such a splint may be at once employed for ambulatory purposes, a shoe with a sole sufficiently high to equalize the length of the limbs being worn on the opposite limb, but in acute cases it is better for the patient to maintain the recumbent position until the acute symptoms have subsided, or to resume this position

should increased pain or deformity indicate an exacerbation of the disease. Taylor's method of reducing deformity by placing the patient upon an inclined plane, with conveniences for adapting the angle to the amount of relaxation gained, is practical and efficient, and will be detailed under the treatment of deformity following hip disease.

So applied in the line of deformity, the splint has necessitated certain modifications. If simply flexion exist, the long bar may be set at an angle to the pelvic girdle, but for adduction or abduction, Shaffer's modification of the pelvic attachment may be employed. This consists of two parts, joined by a lateral hinge. The first part is fastened to the pelvic band, and the second part is attached to the shaft of the splint. Through the everted lip there passes a screw, which operates through a button (which revolves on a horizontal axis), and which is fastened into another button (also revolving on a horizontal pivot) in the first part. By turning the screw, we can either approximate the lip toward the first part (producing *abduction*), or, by reversing the screw, we can separate the lip from the first part and *adduct*.

The writer prefers to overcome the lateral deformity by extension and counter-extension in bed before applying the splint, or should deformity become marked after the use of the splint, to remove it for a time and place the patient in bed until the exacerbation, which this signifies, has subsided. If, however, such a course is inconvenient, the splint may be worn and the patient be placed upon crutches, with a high patten upon the sound limb. This was Taylor's combination method, and the one for which Wyeth claimed advantages superior to all others. Upon this principle also are the combination splints of Lovett and Phelps, modified combinations of the English Thomas splint with the American Taylor splint, both excellent splints for use in cases in which the fixation afforded by the Taylor traction splint is not sufficient. The latter possesses many other excellent qualities, since it is intended to prevent every motion at the hip-joint, and at the same time apply extension in a line with

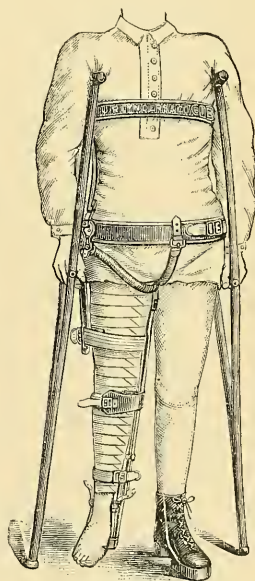


FIG. 321.—PHELPS'S COMBINATION TRACTION HIP SPLINTS.

the neck of the femur, but is a little heavier and more unwieldy than the ordinary Taylor splint.

Convalescent Protective Splints.—After all the characteristic signs have disappeared for a considerable period under traction treatment, it will still be necessary to protect the limb from the jar in walking, and as a precaution against injury. For this purpose the ordinary extension may be employed by simply diminishing the extension and counter-extension until the shoe rests nearly or completely upon the ground. If it is desirable to have a joint at the knee, the convalescent splint of Taylor or one of its many modifications may be employed. In the former, “the lower steel plate is riveted to the upright, but the upper one is fastened by three ‘keepers,’ which enable it to be raised or lowered in adapting the instrument to the length of the leg.”

The use of crutches as a means of protection, the sound limb being raised upon a patten, will be found useful in convalescent cases before abandoning the splint altogether. Protection will be necessary from eighteen months to two years after the complete disappearance of all the active symptoms, and in severe cases even longer, it being better to wear the splint too long than to suffer relapse from its too early removal.

Treatment of Complications.

The complications which will demand special treatment are “night-cries,” abscesses, and malpositions of the limb.

Night-cries usually at once subside under the use of traction in the line of deformity and fixation and the use of local anesthetics of mesotan ointment, 25 per cent., *baum analgesique* Bengue, etc. Should these measures fail, a large blister over the trochanter, followed by hot poultices, with the internal use of potassium bromid and morphin, should be employed. Salicylate of soda in full doses, as for acute articular rheumatism, has been highly recommended. If they continue unabated, operative means must be resorted to. Deep puncture of the joint or trephining of the head of the femur offers the greatest chance of relief, if induration or great fullness of the capsule can be recognized. Where these cannot be discovered, a formal incision into the joint, as an exploratory operation, should be undertaken. The extension weight should be increased, and where excruciating pain is the principal symptom, and it is not relieved by any of the measures suggested, excision will usually reveal the entire separation of the epiphyseal cap of the head by granulation, without a drop of pus being within the joint. The sudden subsidence of night-cries indicates

the efficiency of treatment or the rupture of the capsule of the joint and the extravasation of pus.

Abscesses in many cases will rupture spontaneously, but should they assume enormous size, or exhibit a tendency to burrow to great distances, they should be incised. Small recent abscesses will sometimes disappear under the use of compound iodine ointment and pressure. Aspiration is usually unsatisfactory, and the subsequent injection of antiseptic solutions is not unattended with danger, and is not to be recommended.

Some orthopedic surgeons believe in the spontaneous absorption or rupture of abscesses, urging the danger of septic or tubercular infection for their fear of interfering.

My own opinion is that if they are enlarging rapidly, or tending to spread, they should be evacuated at once under antiseptic precautions by incision. The cavity should be entirely washed out by, first, a continuous flow of bichlorid solution and then sterile water, it should be thoroughly rubbed with gauze pads or cureted, and drainage should be inserted, and one or two drams of iodoform emulsion be injected, and the whole covered by a full, dry, sterile dressing. If the abscess is to be evacuated, it should be thoroughly performed; or if a simple incision is used, care should be taken to avoid pressure upon the part.

The influence of incision and drainage upon the mortality of hip disease is shown in the statistics of Marsh at the Alexandra Hospital. Before the introduction of this method the mortality in suppuration cases was 30.4 per cent., and in non-suppurating cases was 7 per cent.; since incision and drainage have been used as a routine method in 614 cases, the mortality was only 6 per cent.

In opening an abscess an exploration of the joint cavity, if accessible, may, under aseptic precautions, be made.

In all instances in operating upon an abscess the surgeon should be prepared to remove sequestra or to proceed with an erosion or excision should the exigencies of the case demand it.

The Treatment of Sinuses.—The treatment of sinuses following tuberculous abscesses is the *bête noire* of orthopedic surgery at the present time.

If the rubber drainage-tubes are not allowed to remain in too long, and if the packing is diminished as quickly as possible, the sinuses will more frequently close than if these points are omitted. The closure of the sinuses may often be hastened by curetage and by the use of pure iodine applied to

the walls by means of an applicator. The sinuses should not be closed as long as there is any necrosed tissue at the bottom of the wound, and granulation should be encouraged from the bottom of the wound.

The closure of the sinuses following tuberculous arthritis is frequently followed by disease elsewhere, and this has led to the belief among the laity that the closure of sinuses is not a proper method of treatment. Not infrequently the sinus closes spontaneously because of the occurrence of disease elsewhere. If the necrosed tissue has been properly removed there will be no danger in the healing of the sinuses.

Deformity.—The correction of the malpositions of the thigh incidental to the disease has already been given. Recumbency, with continued extension, will often accomplish correction, even in severe grades of fibrous ankylosis.

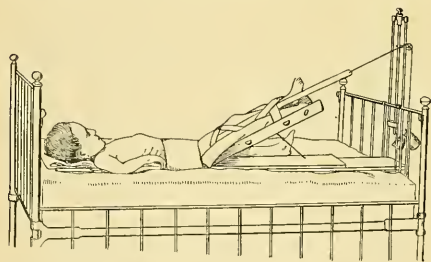


FIG. 322.—APPLIANCE FOR ELEVATING OR ADDUCTING LIMB.

In bony ankylosis, as in fibrous ankylosis, where mechanical means have failed operative measures should be employed.

These include multiple myotomy and tenotomy, *brise-ment forcé*, osteoclasis, and osteotomy. These forcible measures should not be used in suppurating cases until one year has elapsed after

the closure of all sinuses, lest an active process be re-established.

Multiple myotomy and tenotomy. The contracted structures which will require division are the tensor vaginæ femoris muscle, the fascia lata, and the intermuscular ligament between the rectus femoris and tensor vaginæ femoris. These can be divided subcutaneously in the majority of cases; but, if the muscular contraction be more extensive, an open incision under antiseptic precautions should be performed after the V-shaped method of Billroth. This would prevent the injury of large blood-vessels or nerves, but would not otherwise facilitate the correction of the deformity, since the skin is unimportant in maintaining the contraction. In rare cases the psoas and iliacus may require division. This should always be performed through an open incision on account of the immediate proximity of the femoral artery and its branches, although a successful case of subcutaneous section has been recorded by Abbe.

After multiple tenotomy the limb should be brought into a corrected

position, manual force being employed if necessary, and retained either by plaster-of-Paris dressing or preferably by weight-extension. If fracture of the surgical neck occur before the deformity yields to the manual force, it does not complicate the case, since the deformity may then be corrected and the fracture be dressed subsequently as after mechanical osteoclasis.

Brisement forcé. In forcible manual correction there is always some risk of the manipulations lighting up an active process in an old quiescent tuberculous deposit, in true bony ankylosis, and osteoclasis or osteotomy is therefore preferred. If, however, the ankylosis be of the false variety, as shown by the skiagraph, forcible measures may be used. Mechanical osteoclasis for the correction of hip deformity lacks precision, and has of late been abandoned for the more exact and, under the present antiseptic measures, equally safe operation of osteotomy. •

Osteotomy. Under this head are included several operations, all of which aim at a correction of the bony deformity, with or without a movable joint.

To Barton, of Philadelphia, in 1826, belongs the credit of first successfully correcting osseous hip ankylosis by osteotomy. This operation consisted of a linear section through the femur between the trochanters.

Attempts have been made at various times to produce artificial joints, thus: Rodgers, of New York, in 1830 modified the operation by removing from between the trochanters a disk-shaped piece of bone. Sayre still further modified the operation by removing a segment of bone from the same situation, the upper section being semicircular, with its concavity downward, and the upper end of the lower fragment being rounded off in imitation of a ball-and-socket joint. These attempts usually result in failure, and I have abandoned them.

The attempt to produce artificial joints has been revived by Murphy.* Utilizing the efforts of Verneuil, Helfrich, and Cramer, and as a result of experimental work, he has re-established the function of joints by interposing fascias between the ends of bones. The interposed material must contain considerable quantities of fatty tissue, which, being subjected to pressure, forms the hygroma or lining membrane of the joints.

The same idea of interposing foreign materials to prevent union had previously been employed by Chlumsky, who used plates of celluloid, silver,

* "Jour. Am. Med. Assoc.," May 20, 1905.

zinc, and rubber, layers of collodion, cambric, etc., none of which were satisfactory; he also partially failed with the use of absorbable materials, such as magnesia, ivory, and decalcified bone.



FIG. 323.—BILATERAL ANKYLOSIS IN WHICH ATTEMPT TO PRODUCE ARTIFICIAL JOINT FAILED.

Gluck has utilized a cutaneous wedge in ankylosis of the mandible.

The first portion of the operation of Murphy was for ankylosis of the hip due to purulent arthritis, and consisted of a sequestrotomy; the second portion was a curetment; the third operation was through the abdominal cavity to

reach the acetabulum, the necrotic head being removed. The fourth operation was for complete bony ankylosis; through a large U-shaped incision the trochanter was exposed and divided, the femur was separated from the acetabulum by a curved chisel, a portion of the fascia lata was interposed, and the trochanter united with wire sutures. The result was 20 per cent. rotation and from 20 to 30 per cent. of flexion and extension with $1\frac{3}{4}$ inches shortening. This successful case reopens the entire subject of the making of artificial joints after ankylosis, but as yet no successful case for true ankylosis following hip disease has been recorded.

Adams, in 1869, divided the neck of the femur through a small wound. Gant, in 1872, introduced his infra-trochanteric operation, dividing with a saw the femur below the lesser trochanter. Volkmann, in 1873, removed a wedge-shaped piece from the outer side of the greater trochanter of the femur, breaking the rest; subsequently substituting an excision of the joint with a chisel and a gouge, first performing a regular linear osteotomy.

Gant's operation has been modified by Maunder by dividing the femur below the lesser trochanter with chisels instead of the saw, and Macewen's osteotomes have also been successfully employed by a number of surgeons, including the writer. Of the various methods it may be said that false joints are of doubtful utility if obtained, besides increasing the danger of the operations—the mobility of the pelvis compensating for the loss of a movable articulation. The operations, therefore, of Adams and Gant (modified) are to be preferred in suitable cases, the former being employed where the ankylosis has resulted from acute traumatic inflammation and the neck

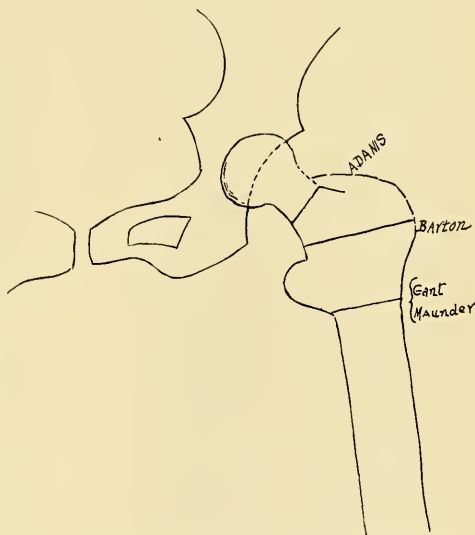


FIG. 324.—DIAGRAM OF DIFFERENT FORMS OF OSTEOTOMY FOR ANKYLOSIS OF HIP.

remains long and intact, and the latter in all other cases of bony ankylosis of the hip-joint.

The application of the operation of division of the neck of the bone is necessarily limited, and Adams considers most favorable for operation: (1) Cases of rheumatic ankylosis, because in rheumatism no destruction of the bone exists, and the head and neck of the bone always remain of their full natural size. (2) Cases of ankylosis after pyemic inflammation, most especially in its subacute form, from which the patient often recovers; in these cases destruction of the bone rarely, if ever, exists, the cartilages only being more or less destroyed. (3) Cases of ankylosis after traumatic inflammation of the joints, in which little or no destruction of the bone occurs. (4) The most unfavorable cases for operation are those which occur in tuberculous subjects, where destruction of the head and neck of the femur has taken place.

The object sought in either operation is the correction of the deformity by more or less firm fibrous union. Adams's operation, from the destructive character of hip-joint disease, is inapplicable in most cases of this nature.

The fact that section of the femur below the lesser trochanter, in addition to the advantages previously mentioned, gives better results in correcting the deformity and in lessening the chances of recurrence, is explained by the contraction of the *psoas magnus* and *iliacus internus* muscles inserted into the lesser trochanter. When the section is made below this insertion these muscles remain attached to the upper fragment, and do not, therefore, interfere with the straightening of the thigh. The section should be made as close as possible to the lesser trochanter, for the shorter the upper fragment the less perceptible will be the resulting angle of union, and the more natural the appearance of the limb.

Adams's operation is thus performed: The parts having been sterilized, a narrow, straight bistoury, or a special tenotome with a very long rounded or blunt portion and a cutting surface a little over an inch long, is entered a little above and in front of the great trochanter, and carried straight downward and backward to the neck of the femur, dividing the muscles and incising the capsule freely. The knife is then withdrawn, the narrow, firm, pistol-handled saw is introduced, and the neck divided. If, after the neck be severed, the *rectus*, *tensor vaginae femoris*, *adductor longus*, or *sartorius* tendons resist correction they should be divided with the tenotome. Aseptic precautions are essential, and recumbent extension should be maintained for five or six weeks.

Gant's operation, as modified by Maunder, is thus performed: The parts having been sterilized, and a marble slab or large sand-bag having been placed between the thighs and high up as the perineum will allow, a sharp-pointed, narrow, straight bistoury is entered just below the great trochanter

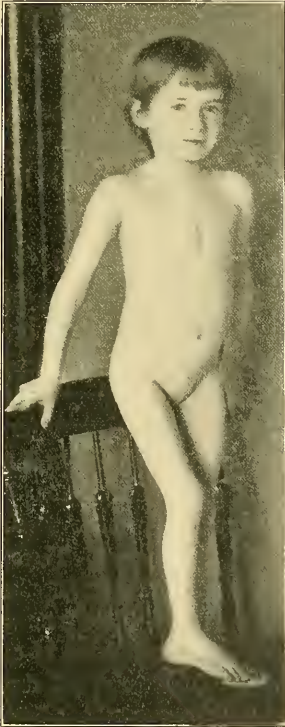


FIG. 325.—GANT'S SUBTROCHANTERIC OSTEOTOMY FOR ANKYLOSIS FOLLOWING HIP-JOINT DISEASE, BEFORE OPERATION.



FIG. 326.—SAME, AFTER OPERATION.

upon the outer aspect of the thigh, and carried directly to the bone, completely incising the soft part. It is withdrawn, and the osteotome introduced with its blade in the direction of the long axis of the femur, and turned at right angles as it reaches the bone. The osteotome is then driven with sharp blows until the spongy structure of the bone is divided, when the instrument is to be

withdrawn, and fracture completed with but little force. The limb is then brought straight, tenotomy being performed, if necessary, upon the resisting structures. A sterile pad and a weight-extension complete the dressing. In children, and whenever practicable, it is best to inclose the leg, thigh, and trunk in a plaster-of-Paris dressing. Should the limb be shorter than its fellow, provision may be made for this for abducting the limb sufficiently to compensate for the subsequent obliquity of the pelvis after recovery. The permanent shortening may be relieved by the use of a high shoe or patten, or one of the special apparatus designed for this purpose.

The statistics of these two operations are at present unreliable, but under strict antiseptic methods these operations are the most satisfactory in surgery, and the risks as regards suppuration, limb, or life are no greater than in simple fracture of these portions of the femur.

Operative Treatment.

So efficient is conservative mechanical treatment in the management of this disease that operative treatment is seldom or never required in private practice where the patient has been under complete control of the surgeon from the inception of the disease. In hospital practice, and in neglected and badly treated cases, operative measures become absolutely necessary for the salvation of life or limb. The proper selection of cases for operation is most difficult, and will depend much upon the diagnostic skill of the surgeon. The use of skiagraphs render the diagnosis more accurate. Operative treatment should always be preceded by thorough mechanical treatment. There are conditions in which the propriety of operative interference cannot be questioned, and in albuminuric cases from prolonged suppuration, or where from great destruction of tissue or exquisite prolonged pain, as in acute cases of caries sicca without suppuration, dissolution is imminent. Other cases will depend almost entirely upon the surroundings and social condition of the individual, since in private cases in whom mechanical treatment is thoroughly and intelligently carried out, the necessity for operation is exceedingly rare.

The operative measures employed in the treatment of hip disease include:

1. Aspiration of joint fluid.
2. Trephining and drilling.
3. Incision of joint.
4. Exploratory incision, erosion, and drainage.

5. Excision.

6. Amputation.

Aspiration of Joint Fluid.—The removal by aspiration of joint fluid in cases of induration and great distention of the capsule is of great utility, especially in acute cases. In traumatic synovitis, which may speedily degenerate into a tuberculous arthritis, aspiration may at once arrest the disease. If the parts, hands, and instrument be sterilized, no harm can possibly result from aspiration. The puncture may be made anteriorly a little above and in front of the great trochanter, but is preferably made posteriorly behind the great trochanter. In removing the aspirator care should be taken to prevent the ingress of air, and the wound should be sealed with iodoform collodion and cotton or a sterile dressing. Rest and extension in the line of deformity should be subsequently continued until all active symptoms have subsided. The injection of germicidal solutions is not recommended and the use of iodoform emulsion, useful in smaller joints, is not satisfactory here, since it acts as a foreign body and has to be subsequently removed.

Trephining and Drilling.—As proposed and performed by Fitzpatrick, the operation consists in trephining into the great trochanter a short distance and attempting to destroy the diseased area by inserting a stick of potassa cum calce. As revived by Stoker and performed by Lovett and others, it consists in trephining with a small trephine from the outer surface of the great trochanter in the direction of the axis of the neck as deeply as possible without injury to the joint, and subsequently with a curet evacuating the diseased focus; a drainage-tube and aseptic pad complete the dressing. Others employ a drill or gouge in the same manner. The operation is a recognized and valuable one where the disease is confined to the epiphyseal juncture of the upper extremity of the femur, but even these would appear to the writer to be better treated by exploratory incision and erosion, presently to be described.

Incision of the Joint.—A straight posterior incision behind the great trochanter is of great service where in acute cases aspiration in the same locality has failed to relieve the capsular distention and acute pain. It has also the advantage of permitting the removal of diseased and softened bone by means of a curet. A narrow straight bistoury is entered behind the great trochanter and thrust directly to the joint, incising the capsule. The benefit, if any, is at once experienced. As a simple incision it has no particular advantage over aspiration, except cases in which the joint contents are too thick to pass through the aspirator.

Exploratory Incision, Erasion, and Drainage.—As performed by Willard, the operation consists in making an incision over the most dependent portion of the abscess, avoiding the large vessels and nerves, and also paying attention to the integrity of the muscular fibers as far as possible, or following sinuses if they exist. By irrigation with hot sublimate solution (1 : 2000) a protective layer of coagulated albumen is formed upon the freshly cut surface to prevent tuberculous infection. The opening into the joint is enlarged and with a hollow-handled sharp spoon every portion of diseased tissue that can be reached is cut away. I have modified this by cauterizing the cut surfaces of the incision with the Paquelin cautery, before cureting, in order to prevent absorption. The spoon Willard employs is a sharp Barker spoon with a bulky handle tunneled longitudinally with a large bore so as to allow a free flow of water from the rubber supply-tube. The roughened ends of bone are sawed off or gnawed by strong rongeurs, and diseased fragments of soft tissue are removed with knife and scissors. A rubber drainage-tube is inserted and the wound is packed with sterile gauze. A large aseptic dressing and compress cover the wound. The operation as thus performed substitutes in many cases the graver operation of excision, and where the bone destruction has been small it offers great advantages over the latter operation.

Rest, weight-extension, and fixation are essential to a cure, and should be continued until every sign of the disease has disappeared.

Excision.—In cases requiring operative interference where exploratory incision reveals areas of diseased bone too extensive to be removed by erasion, excision will be required. In well-selected cases it is an operation of great value, and one which, since its introduction fifty years ago by Sir William Ferguson and his school, has had an important effect in diminishing the number of amputations for joint disease. It must not, however, be forgotten that the operation of excision is, in every region of the body, at least as fatal as the corresponding amputation. It should not become a routine practice in bad cases, nor should it in selected cases be considered as a *dernier ressort*.

Excision of the hip-joint for tubercular arthritis should be thorough when it is required; and there are two points which should be insisted upon in all excisions: first, the preservation of the body-heat, and, secondly, rapidity of operation. The electric mattress has proved very valuable in preventing the loss of body-heat, and has also prevented shock in the majority of cases. There are few operations in surgery in which the shock is more profound than in excision of the hip.

Rapidity of operation is quite as important in orthopedic surgery as in acute surgery, although it requires more experience and greater skill to perform these difficult operations rapidly. The watchwords in operations of this kind should be "Quickly, safely, and well." Much delay in operations may be avoided by planning well before beginning to operate, by having a good corps of assistants, and by rapid manipulation at the time of the operation.

Excision of the hip-joint. Of the many incisions recommended, the lateral or postero-lateral is the most satisfactory. A straight or slightly curved incision is made, beginning at a point one inch above and behind the trochanter, and passing downward and slightly backward curving behind and around the trochanter for a distance of from four to six inches, including the skin and fascias. The separation of the fibers of the gluteus maximus exposes the capsule, the division of which should be cautiously made with a probe-pointed bistoury. When practicable, the periosteum should be stripped back, and preserved as much as possible. The head of the femur, or what remains of it, should be pushed out of the acetabulum by rotating and adducting the limb, and the femur should be removed with cutting forceps or saw immediately below the great trochanter.

If the acetabulum be diseased, it should be thoroughly cureted and all necrosed fragments should be removed with gouge forceps or thumb gouge. The removal of the entire acetabulum is not recommended here.

All sinuses should be thoroughly cureted, and where possible they may be used for the primary incision. Drainage should be provided posteriorly. Drainage-tubes should be inserted and the wound should be irrigated with saline solution and packed with sterile gauze. The limb should be fixed in a plaster dressing or the patient may be fixed in a frame and bed traction be applied.

An anterior incision, as recommended by Barker, is sometimes satisfactory where the disease is confined to the head and neck of the femur. It begins just below the anterior spine, and is carried downward in the longitudinal axis of the femur, for four inches. The capsule should be divided and the neck of the femur should be severed with an osteotome or Adams saw. Posterior drainage is usually required. The after-treatment is the same as for the lateral incision.

It should be remembered that excision is less satisfactory in the hip than in the knee, ankle, or elbow, because of the difficulty of removing entirely the disease in the acetabulum. One exception requires explanation: the

performance of excision upon a patient suffering from amyloid disease of the kidneys. Though considered a contraindication by most systematic writers upon surgery, when indications of commencing amyloid disease make their appearance, excision is almost imperative to check the drain upon the constitution, notwithstanding the immediate risks of the operation, and may be undertaken with strong hope of arresting the kidney disease.

The views of accepted authorities upon the indications for excision are contradictory, some considering it a last resort, others employing it as an accepted method of treatment in selected cases, while still others resort to the operation in all cases once suppuration has occurred.

These contradictory opinions can only be reconciled by considering the circumstances under which such opinions were formed, the character and surroundings of the patients, the facilities for thorough conservative treatment, etc. Such a comparison is obviously impracticable here. In general, it may be said that careful conservative treatment should always be carried out for a long time; that where required early excisions are preferable to late operations, particularly in hospital and dispensary patients, where continuous conservative treatment is impracticable; that whereas the time required for treatment by excision is shorter than by conservative methods, the mortality is higher and the resulting limb less useful.

The ultimate results of excision are well shown in Wright's second series of 100 cases performed since the introduction of the antiseptic method. These were:

- 17 soundly healed,
 - 57 unhealed,
 - 13 dead,
 - 5 dying or going down-hill,
 - 2 in bad condition,
 - 1 might need amputation,
 - 4 amputated,
 - 1 recent case doing well.
- 100

The ultimate results are not as satisfactory; thus, König in 21 excisions lost 47.6 per cent. from tuberculosis in four years. Where patients ultimately recover, the functional results are often excellent, a good movable joint being sometimes secured upon which the individual can dance or skate.

The writer firmly believes that where cases are treated by conservative

methods from the incipency of the disease, operative treatment will be only exceptionally required, and that exploratory incision, erosion, and drainage should have the precedence over excision in all cases where it is possible to employ the more conservative operation.

Amputation.—After the introduction of excision, amputation for hip disease for a time fell into disuse. Since, however, there has been a tendency to revive amputation in selected cases, the question of its indications, its mortality, etc., require consideration. It is indicated where the femur is so extensively necrosed that excision would not entirely remove all the disease, and in descending osteomyelitis. It is not indicated where caries of the pelvis is so extensive that removal of the limb would be of little service except in arresting the drain upon the constitution, nor does the writer believe it indicated in amyloid disease, where excision is all that is required to check suppuration and all the shock such patients can bear, nor is it justifiable where the patient is moribund. Where extensive pelvic disease coexists with disease of the shaft of the femur, it may be performed primarily before, or subsequently to excision, but it is most suitable in cases of extensive disease of the shaft of the femur, without involvement of the pelvis. A successful case is illustrated here through the courtesy of Dr. W. P. Bolles, of Boston, who performed the operation. In adults excision is less satisfactory than in children, and, according to Wright, "amputation should always take the place of excision after puberty."

The mortality of amputation at the hip-joint is not so great after hip disease as for injury or other disease. Ashhurst has collected 34 cases of *primary* and 31 of *consecutive* (*i. e.*, after excision) amputations, with 19 deaths—a mortality, rejecting 5 cases in which the result was undetermined, of 32 per cent. In amputation for hip disease, then, according to Ashhurst's table, the mortality was 19 deaths in 60 cases, or 27 per cent., whereas in the more recent table



FIG. 327.—PHOTOGRAPH OF CASE SHOWING GOOD RESULT AFTER EXCISION OF THE HIP-JOINT FOR HIP-JOINT DISEASE.

collected by Bradford and Lovett it was but 3 deaths in 22 cases, or 14 per cent., thus confirming the statement of Wright that "amputation at the hip, performed with due precautions as to hemorrhage and shock, and special care during the first twenty-four hours, is not a very fatal operation in children." In 7 amputations performed by Wright, in 6 of which excision had been previously performed, 6 recovered well from the operation, and 1 died from hemorrhage.

More recently Wyeth* reported the mortality as having been reduced to 11 deaths in 85 cases, or 15.29 per cent.

The absolute control of hemorrhage, or the so-called "bloodless amputations," especially the pins of Wyeth, are of the greatest service here, and the Furneaux-Jordan method of amputation possesses certain advantages; that is, an amputation of the upper third of the thigh and removal of the femur through a lateral incision. For the various methods of operating and the best means of controlling hemorrhage the reader is referred to works upon general surgery.

In conclusion, amputation at the hip-joint for hip disease may be considered as the very last resort, to be employed only when the disease in the femur is too extensive to be removed by resection, contraindicated by extensive amyloid disease or a fatal asthenic condition of the patient.

The treatment of double hip disease. Since the hips are seldom affected at the same time, the treatment of the disease in both hips does not differ greatly from the treatment in one hip.

Recumbency must be continued longer, greater care must be used to prevent deformity; it is also important, if possible, to avoid complete bony ankylosis in both sides, and for this reason forcible and more persistent attempts may be undertaken to break up the adhesions earlier. If bony ankylosis occur, full extension is a more satisfactory position than flexion. If bony ankylosis occur in flexion, it should be overcome by osteotomy.

Treatment of other forms. In the acute tuberculous form early incision and drainage are more frequently required and the greatest care should be employed to prevent general infection. In the fibroid or chronic form when abscesses occur, excision is more frequently necessary. In these cases also the use of alteratives, both general and local, will be found of signal service.

* "Ann. of Surg.," xxv, 1897, p. 127.



FIG. 328.—UNILATERAL HIP-JOINT DISEASE AFTER EXCISION.

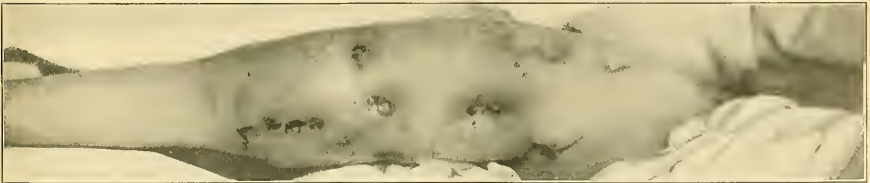


FIG. 329.—SEVERE FORM OF FEMORAL HIP DISEASE (Case of Dr. W. P. Bolles).

CHAPTER V.

NON-TUBERCULOUS DISEASES OF THE HIP.

The affections of the hip non-tuberculous in nature include about 25 per cent. of all the affections of the hip; by far the larger number being tuberculous.

According to König,* the relative frequency and the degree of importance of the different affections of the hip-joint causing disability are as follows:

1. Tuberculous disease,.....	568
2. Acute infectious arthritis after typhoid fever, scarlatina, etc.,.....	110
Coxa vara,.....	5
Tumors,.....	2
3. Gonorrheal arthritis,.....	30
4. Arthritis deformans,.....	22
5. Contractions and ankylosis, cause unknown,.....	6
6. Pyemic suppuration,.....	3
7. Injuries,.....	11
Total, ...	757

Traumatism.

Injury or strain of the hip in young children frequently produces a condition closely resembling hip disease and often confounded with it. The characteristic symptoms of affections of traumatic origin in the hip are pain and discomfort consequent upon any overexertion, which is felt particularly at night. The pain experienced is such as is commonly known by as "growing pains," and there is sometimes limitation of motion with a slight limp. The injury is liable to cause a congestion in the region of the head of the femur and around the cartilage, and this congestion, in connection with the resulting lessening of the local resistance, may be a cause of subsequent tuberculous affection of the joint. If the injury be very severe, the joint may become enlarged and sensitive upon motion or pressure, and may be followed by a synovitis.

The treatment for traumatic affections of the hip consists in extension

* "Die Specielle Tuberculose der Knochen und Gelenke," "Das Hüftgelenk," Berlin, 1902, vol. ii, p. 3.

in bed, with counter-irritation, which should be continued for several weeks, and until all the symptoms have entirely disappeared.

Synovitis of the Hip-joint.

The hip is subject to the different forms of synovitis described elsewhere—acute serous, chronic serous, and chronic joint hydrops.

The causes of acute synovitis of the hip are many and varied. It may result from traumatism, exposure to cold or dampness, or it may result from over-exertion. It may occur as a part of a general inflammatory condition, as acute articular rheumatism, syphilis, or gout, and very frequently it occurs as a sequel to infectious diseases, such as a pyemic process in pneumonia, scarlatina, typhoid fever, pyemia, septicemia, diphtheria, erysipelas, dysentery, puerperal fever, smallpox, measles, typhus, and varicella.

In many of the infections the particular germ of the disease has been formed in the synovial fluid, but in some the ordinary germs of suppuration have been found without any specific organism, and in some the fluid evacuated has been found infectious, as in gonorrhea, from pure cultures, without the presence of the specific germs of suppuration.

In the majority of instances the hip is less frequently affected than the other large joints. This is well shown in a series of cases collected by Lovett* from various sources and shown in the following table:

The knee was affected.....	357 times
The ankle was affected.....	284 times
The wrist was affected.....	249 times
The shoulder was affected.....	229 times
The elbow was affected.....	148 times
The hip was affected.....	103 times
The fingers were affected.....	81 times
The feet were affected.....	45 times
The hands were affected.....	44 times
The toes were affected.....	29 times
The spine was affected.....	16 times
Miscellaneous joints.....	8 times
	1593 times

The same is also shown in the series of 375 cases of gonorrheal infection collected by Frazier, in which the hip was affected 18 times and the knee 136 times.

* "Diseases of the Hip-Joint," 1891.

Symptoms.—The chief symptoms are weakness, stiffness, and severe pain on motion. On account of the deep location of the joint, swelling is difficult of detection during the early stage, but later the surrounding structures become baggy and edematous. The general condition is at first not influenced by the joint infection, but subsequently upon the formation and rupture of pus into the surrounding structures the constitutional symptoms are marked and alarming. When the joint infection occurs as a complication in the course of a disease, the symptoms are pyemic in character.

Treatment.—The treatment of simple acute synovitis consists of bed extension and counter-irritation,—a fly-blister applied back of the trochanter will be found useful in the milder forms, and ichthyol ointment, 50 per cent., combined with lanolin and petrolatum to which has been added a few drops of oil of citronella, will be found a useful application. If the symptoms do not quickly subside, the joint should be aspirated behind the trochanter. If the fluid obtained be purulent, a free incision of the joint should at once be made. This can best be accomplished by an incision posterior to the trochanter, or, if fluctuation be detected in front in the adductor region, the anterior incision described under excision of the hip may be used, or through a skin incision in the adductor region, the muscles may be separated and the joint be readily incised.

Ankylosis is liable to follow this condition, and should be overcome by forcible correction in mild cases, but in severe cases osteotomy may be necessary.

Deformity is sometimes very great from the abduction and flexion of the femur, the limb being fixed at a right angle to the body and carried far out to one side.

Chronic Serosynovitis of the Hip.

The acute condition may become chronic or it may be primarily chronic from other causes than tuberculosis and arthritis deformans, or it may throughout its course consist in an inflammation without excessive secretion of the synovial fluid,—a dry synovitis, or the so-called *arthrite plastique ankylosante*. The main causes of chronic synovitis have already been described under the acute condition. The chronic condition produced by exposure, insufficient food, and unhygienic surroundings is sometimes described as *arthritis pauperum*.

Treatment.—The treatment consists in the administration of tonics, anti-rheumatic remedies, together with improved diet, and counter-irritation by the use of compound iodine ointment or the actual cautery.

Acute Arthritis of the Hip-joint.

This affection is one which is found in young children, chiefly in the early weeks of life, and is of a suppurative character, originating, as a rule, in the epiphysis and from thence infecting the joint. It is generally pyemic in character, but may be due to traumatism, to infection of syphilitic or suppurative character, particularly suppuration of the umbilicus, or it may sometimes occur as a sequel of diseases common to childhood, such as chicken-pox, measles, scarlatina, or as a result of typhoid fever, or it may be due to pertussis. The origin is obscure and difficult to determine. The infecting germ is usually the staphylococcus aureus or albus, or the streptococcus.

The disease is characterized by a sudden onset, and there is usually a considerable elevation of temperature, the child being greatly prostrated. There is swelling in the hip, with sensitiveness upon motion or palpation. Suppuration is an early and persistent feature of the affection, and the usual course is the destruction of the epiphysis, with a consequent loosening of the joint, giving the appearance in cases which have recovered of an apparent congenital dislocation. On account of the septic nature of the disease it is sometimes difficult to differentiate it from tuberculosis, and in less severe cases this may only be done by making a bacteriologic examination of fluid aspirated from the joint.

Treatment.—The treatment should consist first in an effort to check and overcome the septic process of destruction, and to this end early and efficient drainage should be carried out, making a free incision; where it is possible, the line used for resection of the joint should be followed, and the joint entered back of the femur. The drainage should be so thorough that no drainage-tubes need be used. The presence of fluctuation and cellulitis is the indication for the free incision and drainage, and cannot be undertaken at too early a period. After the drainage is established the area should be left open, with only the application of some simple antiseptic poultice or dressing, as it is well understood that children in the early months of life stand corrosive dressings very well. If the child be very feeble, the incision may be quickly made without anesthesia, and subsequently the carious bone may be removed; but if the child be strong, the diseased bone may be removed at once under an anesthetic. The joint should be given as much rest as possible, and because of the intense sensitiveness which characterizes the affection, the diseased joint should be fixed by mechanical means in order to relieve this condition. The hip is usually flexed in acute arthritis and should be fixed in this position, as any attempt at correction would cause unnecessary suffering to the patient. For purposes

of fixation either an anterior pasteboard splint or a plaster-of-Paris spica bandage may be used. Ankylosis is liable to follow, and in view of this fact the joint should be, if at all possible in the earlier stages of the affection, fixed in as favorable a position as possible, but if ankylosis in a faulty position should occur, the after-treatment may be the same as in hip disease.

The prognosis is generally favorable, especially in cases where the affection is in one joint only and the shaft of the bone is not diseased, and where a thorough early evacuation of the pus has been accomplished; but death may occur from the suppurative infection. In twelve cases reported by Townsend* there were three deaths. Recovery is apt to be attended with a certain degree of deformity, and because of this, the joint should be carefully supported for some time after the disease has run its course, to avoid the danger of upward displacement. The most characteristic deformity resulting from the destruction of the epiphysis is an upward and backward displacement, closely resembling that of congenital dislocation, and this may be corrected, under anesthesia, in much the same manner as that of Lorenz for the reposition of congenital luxation of the hip.

A full bibliography upon this subject, together with a tabulation of reported cases, may be found in the article by Townsend mentioned above.

Arthritis Deformans of the Hip-joint.

The general subject of rheumatic arthritis will be described in the special chapter devoted to this subject. Since the disease is frequently confined to the hip-joint, this phase of the subject may be described here.

When the hip-joint is the seat of the affection, it is known as *malum coxæ senilis*. Synonyms: *malum senile*, *morbus coxæ senilis*, *senile coxitis*. The origin of this disease has been variously ascribed: to the synovial membrane by Brodie, Adams, Volkmann, and others; to the cartilage by Cornil and Ranvier, Orth, Howard Marsh, Billroth, and Garrod; and to the bone by Barwell and others. It is also called rheumatic or rheumatoid arthritis, rheumatic gout, osteoarthritis, nodular rheumatism, *rheumatisme nouveau*, etc. The pathologic differences are so insignificant that it is more practical to consider them under one disease.

Injury, age, and strain of the part are important local factors in causing this affection, and it is likely to follow fractures of the hip-joint in the aged.

* "American Journal of Medical Science," January, 1890.

The chief characteristics are disintegration and erosion of the articular cartilages and a tendency to increased bony formation about the head of the femur. There has been much discussion as to whether the changes are inflammatory or not. Senator expresses the modern conclusion as follows: "The changes in the joints are partly inflammatory, partly degenerative." In the early stage the synovial fluid is increased, and later it is decreased. Changes in the cartilages are noted in the earlier period of the disease, the cells multiply and there is fibrillary degeneration of the hyaline substance which renders the cartilage more friable than normal. It has a yellowish appearance and the articular surfaces become thinned in the center and hypertrophied around the periphery. Microscopically it appears velvety, and pieces may be split off. Marginal ecchondroses appear which may become so large as to perforate the synovial membrane, and become pedunculated or even detached. Ossification of these ecchondroses begins in the layers nearest the bone.

The early symptoms are neuralgic pains in the limb, "sciatic rheumatism," stiffness and sensitiveness to pressure. The movements of the joints are restricted, and there may be a creaking of the joints. In the advanced stages there is marked thickening around the trochanter, the limb is shortened and distorted, and is held in a position of flexion and adduction, and atrophy is marked.

Treatment.—When limited to a single joint, the advance of the disease may be arrested by improving the general health of the patient, and the administration of stimulants, together with the use of massage and passive motion. Traction with recumbency should be employed for the reduction of the deformity, and later a fixation hip apparatus or support may be applied with positive advantage. Resection of the upper portion of the femur may be required in very severe cases, and successful operations of this character are referred to under the general subject. In the majority of instances where treatment by neither operative nor mechanical means is feasible a strong spica bandage, with the occasional use of the cautery, will afford the patient considerable relief.

Irritation due to arthritis deformans is treated largely by the same measures as joint irritation from other causes—the administration of tonics, salicylate of soda and alkaline diuretics, Vichy water, and the local use of massage, electricity, with rest and protection to the joint. A visit to one of the foreign spas or health resorts will frequently be found beneficial.

Syphilis of the Hip-joint.

The local manifestation of *lues* in the hip-joint is characterized by a chronic synovitis with gummatous formations scattered through the synovial membrane, the bones, and the surrounding structures. Necrosis, disintegration, and pus formation occur, together with a hypertrophic periosteitis, or perichondritis, especially of the epiphysis of the head of the femur.

It is most common in early life as an inherited lesion, during the first year of life, and later from the fourth to the twentieth year.

As an acquired affection it is first apparent in the synovial membrane; gummatous formations are developed, especially beneath the periosteum, and with a tendency to cicatrization, resulting in false ankylosis.

Symptoms.—The symptoms resemble somewhat those of tuberculous osteitis. The joint outline is distinctly enlarged and indurated, the capsule is thickened, but the fusion is so slight that it cannot be detected upon palpation. Motion is limited, but there is an absence of the reflex muscular spasm which is present in tuberculous joint disease, or, if present, it is not so marked, and the atrophy which occurs is slight. Pain is moderate upon motion and may be elicited by firm local pressure. Night-cries are absent.

Treatment.—The treatment should consist in the administration of large doses of potassium iodid, or Donovan's solution administered in medium-sized doses will be found of advantage, together with the local application of mercurial ointment. The general condition should be improved in every way, and some preparation of iron will be found beneficial as a tonic. The joint should be placed at rest by extension or the use of a hip splint, and subsequently motion should be restored by forcible means.

Neuropathic Affections of the Hip-joint.

The neuropathic affections of the joints described by Charcot as being the result of any lesion of the anterior cornua of the cord are frequently observed in the hip-joint. In 169 cases analyzed by Weizsacher the knee was affected 78 times, the hip 31 times, and the shoulder 21 times, etc. The pathologic condition in the hip resembles the lesion in arthritis deformans. There is marked effusion with thickening of the synovial membrane, there is exostosis of bone, and the trochanter is found on a higher plane than normal.

Treatment.—The treatment should be directed to the condition which is the cause of the arthropathy. In many instances little can be accomplished by medical treatment. If there is a history of syphilis, large doses of potassium

iodid, with or without mercury, should be administered. If the joint be greatly distended by fluid, aspiration will be indicated. Traction hip splints are of some value in allaying the pain, but are not always available because of the toxic condition. Incision of the joint has been performed, but is not to be recommended on account of the disturbed trophic condition of the parts.

Malignant Disease of the Hip.

The occurrence of malignant disease of the hip is extremely rare: in 70 cases of sarcoma of the femur analyzed by Gross there were only two affecting the upper epiphysis; but the affection is of sufficient frequency to demand consideration here.

The malignant growth is usually a sarcoma, carcinoma of the bone being seldom met with. The round-cell sarcoma of the periosteum is the variety usually affecting the hip, being the most rapidly growing of malignant tumors found in this locality. There is little or no bone formation and considerable bone destruction. These tumors are excessively vascular, and are alveolar in character, resembling somewhat the structure of carcinomas, having the appearance of aneurysm, with a slight degree of pulsation. The fact that suppuration is very slight renders a differential diagnosis from tuberculous affections of the bone comparatively easy. There is infiltration of the soft parts, with an occasional spontaneous fracture, but this latter condition is found less frequently in the hip than in other malignant tumors of the bones.

The symptoms of malignant disease of the hip are the early and rapid swelling of the part, some limitation of motion, with a slight limp. The swelling increases]as the disease advances, and in time the entire limb becomes distressingly large. Intense pain sometimes characterizes the affection, while in other cases it is so slight as to cause little discomfort. There is no fluctuation present.

The treatment of this affection is not satisfactory, the only methods which give any hope of cure being amputation at the hip or exarticulation of the hip-joint, and this operation should be performed as early as possible after the diagnosis of malignant disease has been established, in order to insure any chance of recovery. It is, however, rarely successful as a curative means. Exarticulation of the hip at the highest point has been attempted with but small success. There have been reported (Wyeth* and Jenckel†) 22 cases

* "Ann. of Surg.," 1901, vol. xxxiv, p. 375.

† "Deutsch. Zeit. f. Chir.," 1902, Bd. lxiv, p. 66.

of malignant growths in the hip which have been cured by exarticulation or amputation, the patients living from three to sixteen years after the operation; but in the majority of these cases the growth was below the epiphysis, and only a very small percentage of cured cases of sarcoma of the upper end of the femur have been reported.

Kramer* has studied extensively the results of various operations for sarcomas of the bones, and because of his exhaustive consideration of the subject his conclusions should take precedence over those of other writers. He, with other authorities, is agreed that only in cases of malignant disease of the upper femoral shaft, or where infiltration of muscle is excessive, is there necessity for exarticulation. Borck† in 87 cases of exarticulation for sarcoma of the hip was unable to find a case positively cured.

Bloodgood suggests that the literature upon the subject of sarcomas of the bone demonstrates that the nature of the tumor should indicate the form of operation required. There are the two varieties of sarcoma, and only in the most malignant type would exarticulation be demanded, or perhaps in cases not so malignant in character where the location of the tumor or the presence of infiltration of the soft tissues warrants this mode of procedure. This theory has been corroborated by a careful study of results obtained in operative treatment for malignant growths in the bones, for thirteen consecutive years in the Johns Hopkins Hospital, collected by Kramer and Jenckel.

When exarticulation has been performed for malignant tumors of the hip, the wound may be inoculated after the operation either with the streptococcus of erysipelas, or if not with this, perhaps with the toxins of streptococcus and the *Bacillus prodigiosus*, which has been recommended by Coley in the treatment of malignant tumors in any locality. The object of inoculating the wound is to avoid the possible danger of recurrence. There is always the danger of internal metastasis.

The final result of operation in malignant disease of the bone, even in the most hopeful cases, is uncertain. According to Kramer, the results after resection and after amputation are equally satisfactory, provided the tumor has affected only the bone and there is no infiltration of the soft parts. If this latter condition exists, exarticulation, with the removal of the area of infiltration, would probably be more successful, except that death is apt to result from internal metastasis. Resection is seldom employed in sarcoma of the

* "Archiv f. klin. Chir.," 1902, Bd. lxvi, p. 792.

† "Archiv f. klin. Chir.," 1890, Bd. xl, p. 941.

hip, as the area of infection is extensive, infiltration of the soft tissues is present, and the occurrence of metastasis is probable. Resection has been advocated by Mikulicz and Weisinger.

The ultimate conclusion based upon a careful consideration of all of the literature upon malignant growths in the bones is that under certain selected conditions resection may safely be undertaken; that in the most malignant tumors, accompanied by muscle infiltration, exarticulation is required; and that in the greater number of cases amputation gives the best results and the most hope of recovery. A most notable case of a cure of metastatic carcinoma at the upper end of the femur, by exarticulation, is reported by Rose.* In this instance the carcinoma of the hip was secondary to an excision for carcinoma of the breast.

Coxa Vara.

Definition.—Coxa vara is the term applied to that deformity in the upper end of the femur in which the normal angle formed by the neck and the shaft of the bone is lessened.

Synonyms.—*English*, Bending of the neck of the femur; Depression or incurvation of the neck of the femur. *French*, Deformations du col du fémur. *German*, Schenkelhals Verbiegungen. *Italian*, Coxovaro, Collum femoris varum; Coxa adducta. *Spanish*, Coxovaro.

History.—Coxa vara as a distinct deformity has been unrecognized until very recent years. While there have been cases reported by Roser, 1843; Zeis, 1851; Richardson, 1857; Monks, 1886; Keetly, 1888; that were undoubtedly true cases of coxa vara, our attention was first called to it as a deformity distinct from hip disease by Fiorani, 1881. E. Muller, 1889, reported four cases occurring in adolescence in which he described the condition present as a distinct affection from hip disease, and to him is given the credit for the first detailed description of the disease. To Hofmeister is given the credit for the term "coxa vara."

Etiology.—The following theories have been advanced from time to time to account for the various forms of coxa vara.

1. Congenital: That cases of congenital coxa vara are due to malposition of the fetus *in utero*.
2. Pathologic: Some writers consider that the condition is caused by a

* "Centralblatt f. Chir.," 1902, Bd. xxix, p. 17.

local disease in the neck of the femur, as osteomalacia, osteomyelitis, rachitis, arthritis deformans, etc., and that, as a result of the weakened condition present, any increase in weight it is required to bear results in a diminution of the normal angle of the femoral neck.

3. Structural Weakness; Static Theory: In certain cases there is probably an inherited delicacy of structure of the support, and any increase in the burden, whether for a shorter or longer period, is liable to produce the deformity.

4. Inherent Weakness: Some writers consider the deformity to be due to overburdening, and classify it with genu valgum infantum and adolescentium. Rachitis in the infantile form or late rachitis in the adolescent may be associated, although in the adult form the signs of rachitis are often absent.

5. Traumatism: This form is shown in those cases in which the deformity is caused by a fracture between the head and the neck of the femur at the epiphyseal line, or occasionally by a fracture, complete or incomplete, through the neck of the femur.

6. Anatomic: (Sudeck's Theory.) In a study of the system of the bone lamellas of the upper end of the femur, two systems are found to be present: one on the adduction side, which sustains the weight of the body, and one on the trochanteric side, which sustains the tension, known respectively as the pressure bow and the tension bow systems. Examination of the neck of the normal adult femur shows a ridge extending from the border of the articulating cartilage of the head downward and outward over the anterior surface. This ridge represents the highest and strongest part of the tension bow and prevents a bending down and back of the neck. Any insufficiency of the tension bow which allows a bending of the neck downward and backward may cause coxa vara. This insufficiency may be caused by a softening or late ossification of this system of lamellas, or by an overburdening during the period of growth when the lamellas have not acquired their normal adult firmness.

Classification.—For convenience and until some definite cause can be ascribed for each individual case, coxa vara may be broadly divided into:

(A) Coxa Vara Adolescentium.

Having a cause common with genu valgum and varum.

(B) Other forms of Coxa Vara.

1. Congenital.

2. Associated with congenital dislocation of the hips.

3. Due to Osteomalacia.

4. Due to Acute Osteomyelitis.

5. Due to Osteitis Fibrosa.
6. Due to Tuberculosis.
7. Due to Senile Atrophy.
8. Due to Arthritis Deformans.
9. Due to Causes Unknown.
10. Due to Traumatism.

Coxa Vara Adolescentium.—Age: In a series of eighty-three cases from the literature of coxa vara the age varies as follows: six congenital; five



FIG. 330.

a, Coxa vara; *b*, normal femur; *c*, coxa valga (Wistar Institute of Anatomy).

between two and five years; five between six and seven years; two between seven and eight years; seven between nine and ten years; one between ten and eleven years; three between twelve and thirteen years; four between thirteen and fourteen years; eleven between fourteen and fifteen years; nineteen between fifteen and sixteen years; eleven between sixteen and seventeen years; three between seventeen and eighteen years; two between eighteen and nineteen years; two between twenty and twenty-one years; and one at twenty-four years.

Sex: From 109 cases selected from the literature, 83 were in males and 26 in females, 85 were unilateral and 24 bilateral.

Deformity: In a review of 68 cases of non-traumatic coxa vara it was found that the bending of the neck is usually downward and backward, following the line of the least resistance, as shown by Sudeck's theory. Occasionally only downward, and rarely downward and forward, as a result of the bending of the neck downward and backward, there is elevation of the trochanter and



FIG. 331.

a, Coxa valga, vertical section; *b*, normal femur, vertical section; *c*, coxa vara, vertical section (Wistar Institute of Anatomy).

outward rotation of the thigh, the former accounting for the shortening, the latter for the limitation of inward rotation.

Angle of Deformity: In examining the normal femur of an adult the angle formed by the neck and shaft is about 125 degrees. In earlier life the angle is greater, in children being about 130 to 140 degrees, and as one advances in adult life the angle gradually lessens to perhaps 110 degrees. Between 110 and 140 degrees may be considered within normal limits. In coxa vara the angle formed by the neck and shaft of the femur may vary from 90 to 40 degrees. The following table gives the position of the lower extremity in 86 cases:

VARIATION IN POSITION OF LIMB. (FRAZIER AND HOFMEISTER.)

POSITION OF LIMB.	HOFMEISTER.	FRAZIER.	TOTAL.
Outward rotation, ...	27	16	43
Outward rotation and adduction, ...	1	5	6
Outward rotation and flexion, ...	0	5	5
Inward rotation, ...	1	1	2
Inward rotation and adduction, ...	1	1	2
Adduction, ...	0	1	1
Adduction and flexion, ...	1	0	1
Normal, ...	5	3	8

In reference to the deformity cases may be divided into the three following groups (Hofmeister):

Group I: Elevation of the trochanter and limited abduction are the characteristic features. The attitude of the limb is usually normal, flexion and rotation being either normal or limited to a slight degree.

Group II: Elevation of the trochanter and outward rotation. In addition to the limited abduction associated with cases in Group I, we find in this group that inward rotation is so restricted that it is impossible to rotate the limb further inward than to a position in which the foot points directly forward. Outward rotation may be possible only to a normal degree, or so far beyond the normal that the patella and foot may point not only directly outward but backward. Abduction and adduction are as described in Group I, the former being markedly restricted or altogether abolished, the latter entirely free. In the majority of cases flexion is unrestricted except when attended with outward rotation and adduction of the thigh,—that is to say, if one attempts to flex the limb he must at the same time adduct it and rotate it outward, or he will soon come to a point where further flexion is restricted. If the affection is bilateral it is now easily seen why, when both thighs are flexed simultaneously, each leg will cross over its fellow. The appearance of such a patient is also quite characteristic, and it is commonly spoken of as the “scissor-legged deformity.” The gait is not unlike that seen in cases of bilateral congenital luxation of the hip. Through the co-operative effect of outward rotation and limited abduction in bilateral cases there exist certain characteristic restrictions in the movements of the legs. For example, such a patient can kneel only with the legs crossed. The explanation of this is apparent: flexion is possible only when the limb is rotated outward, and spreading of the thighs (which would obviate the necessity of crossing the legs) is quite impossible, since abduction is restricted. For the same reason sitting on a stool with the legs close together is impossible, and stooping over to pick up an object from the ground is difficult. The rationale of

this is appreciated when, voluntarily limiting abduction and rotating the limb outward, we try in our own persons to touch the floor with our hands. Such an act is only made possible by the preternatural mobility of the vertebral column.

Group III: Elevation of the trochanter and inward rotation. The functional disturbances of this group correspond with those of Group II, with this exception,—namely, in one we find inward and in the other outward rotation.

Most cases belong to Group II.

Symptoms: The adolescent form of coxa vara usually begins in childhood, but more commonly at the beginning of puberty without apparent cause. In a number of cases there is the previous history of rachitis. Other cases develop without any apparent cause. At times there is the previous history of over-exertion or exposure.

The subjective symptoms come on insidiously, the patient complains of a slight limp on the affected side, usually preceded by an indefinite pain about the hip, at times referred to the knee. Accompanying these symptoms are awkwardness of gait, stiffness, and a feeling of weakness about the hip. At times there may be severe pain and muscular spasm about the hip, usually marked after exertion. As the limp becomes more noticeable there begins atrophy of the thigh muscles. Concomitant with these symptoms deformity begins. This usually consists, as above described (see classification, Hofmeister's), in prominence and elevation of the trochanter, outward rotation of the thigh, upward tilting of the pelvis on the affected side, limitation of abduction, inward rotation and flexion of the thigh, elevation of the trochanter above Nélaton's line, actual shortening as measured from the anterior superior spine of the ilium to the internal malleolus, and marked apparent shortening.

The objective symptoms may be explained by the condition present in the neck of the femur and the altered relations of the trochanter with the acetabulum. As the neck of the femur bends usually in the line of least resistance (see above, Sudeck's theory), which is downward and backward, the trochanter is elevated above Nélaton's line and becomes more prominent, from its altered position at the atrophy of the thigh muscles; at the same time the shaft of the femur is rotated outward. This elevation of the trochanter and outward rotation of the thigh are compensated by upward tilting of the pelvis on the affected side and slight flexion of the thigh. The tilting of the pelvis accounts for the marked apparent shortening. On account of the changed position

of the trochanter, and as the head of the femur is not displaced, abduction is necessarily limited.

In bilateral coxa vara the patient is obliged, on account of the limited amount of abduction on both sides, to assume a very awkward gait, commonly known as the "scissors gait." Walking at times is extremely difficult. In some cases, instead of the neck being bent backward and downward, there occurs a bending forward and downward. In this condition there is



FIG. 332.—COXA VARA, FRONT VIEW (Robert Jones).



FIG. 333.—SAME, LATERAL VIEW.



FIG. 334.—SAME, POSTERIOR VIEW.

inward rotation of the thigh, limitation of abduction, however, remaining the same.

Duration of the Acute Symptoms: In most untreated cases of coxa vara the duration of the acute symptoms is usually from one to four years. This is especially true of cases occurring during adolescence, while in those occurring at an earlier period the symptoms cover an indefinite length of time, and there are, at times, exacerbations of symptoms. Under appropriate treatment,



FIG. 335.—X-RAY OF SAME, LEFT SIDE.



FIG. 336.—X-RAY OF SAME, RIGHT SIDE.



FIG. 337.—COXA VARA, SHOWING "SCISSOR-LEG" DEFORMITY (Morton).



FIG. 338.—SAME, POSTERIOR VIEW.

local and general, the subjective symptoms gradually subside, and the local condition in most cases becomes sufficient to insure sufficient stability.

Diagnosis: This is in most cases made with very little difficulty. A good history, a careful examination, keeping in mind the above symptoms, will generally lead to the diagnosis.

Differential Diagnosis: Cases simulating adolescent coxa vara are:

1. Congenital dislocation of the hip.
2. Hip disease.
3. Local diseases, as osteomyelitis, osteomalacia, arthritis deformans.
4. Traumatic coxa vara.

1. Coxa vara may be distinguished from congenital dislocation of the hip on the following grounds: Coxa vara is usually an acquired condition. In congenital dislocation there is the history of abnormal mobility of the joint from birth, the free mobility of the trochanter being present upon palpation of the head and neck of the femur beneath the tense tissues of the gluteal region on forced flexion and adduction of the thigh.

2. In hip disease there occurs reflex muscular spasm, marked limitation of motion, absence of shortening except in the advanced state, usually local evidences of inflammation and suppuration; whereas in coxa vara the muscular spasm occurs but rarely and then only after prolonged effort, motion is limited only in abduction, inward rotation, and flexion in most cases, and there is early appearance of shortening and absence of local signs of inflammation or suppuration.

3. From local disease, as osteomyelitis, arthritis deformans, or osteomalacia, etc., a differential diagnosis is difficult, and is possible only by an examination of the bone at the seat of the disease.

4. In traumatic coxa vara there can usually be obtained some history of injury. Examination with the x-ray will usually show in the traumatic form an epiphyseal separation of the head, while in the non-traumatic variety the deformity will be found in the neck.

Pathology: An examination of 19 specimens obtained by operation or autopsy showed that the curvature of the neck was associated with supposed rachitis in 3 cases, with juvenile osteomalacia in 2 cases, with arthritis deformans in 2 cases, fracture of the neck of the femur in 2 cases, congenital in 3 cases, and in 7 cases microscopic examination showed no change which could be attributed to any known disease.

Granting the possibility of late localized rachitis, cases of coxa vara

occurring in adolescence should be ascribed to this condition. There have, however, been no cases so far to show conclusively this condition. The relationship of coxa vara adolescentium and infantile coxa vara has been established by observations of Fiorani, Lesser, Ogston, Zender, and others.

Kocher was inclined to consider the histologic changes in his two specimens to be localized osteomalacia.

Burns and Hansell in a report of 106 cases of acute osteomyelitis of the upper end of the femur have observed various curvatures and deformities of the neck of the femur.

No specimens have yet been presented that show conclusively the association between coxa vara and tuberculosis.

Maydl has shown clinically that arthritis deformans juvenalis and coxa vara adolescentium cannot be differentiated. He was able to make the diagnosis only at operation. The most recent work to attempt to explain the cause of this condition on an anatomic basis is that given above. (Sudeck's theory.)

Other Forms of Coxa Vara.—Congenital Coxa Vara: Six cases have been reported. This variety is no doubt caused by intrauterine pressure on account of bad position of *fetus in utero*.

Coxa Vara Due to Osteomalacia: Three cases are reported in which the bending of the neck of the femur was undoubtedly due to localized or general osteomalacia. One case occurred in a puerperal woman.

Coxa Vara Due to Acute Osteomyelitis: In a series of 106 cases of acute osteomyelitis involving the upper end of the femur various curvatures have been observed in the neck and between the head and neck of the femur.

Coxa Vara Due to Osteitis Fibrosa: Several cases have been reported



FIG. 339.—RACHITIC DWARF. FEMORA SHOWING COXA VARA (Wistar Institute of Anatomy).

showing a bending of the neck of the femur in which the local condition was doubtless due to an osteitis fibrosa.

Coxa Vara Due to Tuberculosis: Roser's specimen was considered by Hofmeister to be due to a localized tuberculosis. So far no specimen has yet been found which shows tuberculosis. Very mild cases of tubercular coxitis show a clinical picture of coxa vara.

Coxa Vara Due to Senile Atrophy: An exaggeration of the decrease of the normal angle between the neck and the shaft of the femur often takes place, and at times the deformity may be extreme.

Coxa Vara Due to Arthritis Deformans: While this deformity is rarely seen during adolescence, occasionally it occurs, and is hard to differentiate from the form due to rachitis except by operation.

Coxa Vara Due to Causes Not Known: Seven specimens are reported in which the histologic findings were negative. Whether these cases can be accounted for by structural weakness yet remains to be proved. Usually the work done by the individual during the period of growth is out of proportion to the strength of the bone. (Sudeck's theory.)

Traumatic Coxa Vara: In this condition there is present as a result of injury all the symptoms of non-traumatic coxa vara. The curvature of the neck of the femur has been shown by specimens and x-ray pictures to be due in most cases to an epiphyseal separation of the head of the femur, and in a few cases to a fracture through the neck of the femur. Of eighty-eight cases in the literature, in only four have we pathologic or x-ray proof that the fracture was in the neck and not in the epiphyseal line.

Anatomy: The anatomy of this so frequently overlooked fracture in young individuals must now be considered to be established as a partial or complete epiphyseal separation in the majority of instances.

Age: The age of the patient in the above cases varied from one to twenty years, the most common age being between thirteen and sixteen years, but it is very important to bear in mind that seventeen cases have been observed between one and five years of age.

The complete separation is much less common than the incomplete. The former produces immediate symptoms and can be easily recognized clinically; the latter, the incomplete separation, gives little or no immediate symptoms, which only develop weeks and months later, and, as the injury may have been slight, a diagnosis of tubercular coxitis is frequently made.

Hoffa divides the cases into two groups: (1) in which the epiphyseal sepa-

ration takes place in healthy children, and (2) in which the fracture occurs in a femoral neck, the strength of which is weakened by some pathologic process. In the first group the symptoms all date from the injury, in the second group a history of certain typical symptoms can be obtained which become exaggerated after the injury. Non-traumatic coxa vara predisposes to traumatic coxa vara.

Symptoms: At various times after a slight injury the patient begins to complain of pain in the hip, and walks with a limp. Examination shows outward rotation, adduction, shortening, and slight flexion. Abduction and inward rotation limited. The trochanter is above Nélaton's line. The symptoms are analogous to the non-traumatic variety. X-ray examination shows an epiphyseal separation of the head or a fracture through the neck of the femur.

Diagnosis: In all cases if one is very painstaking there is always the history of trauma to be obtained. This may be very slight and may have been overlooked by the patient; in other cases patients give the history of falling from a considerable height. After the injury the patient may immediately complain of pain about the hip, at times referred to the knee. This is usually accompanied by slight muscular spasm on exertion, shortening, and all the symptoms of a well-advanced non-traumatic case. In some instances the patient is able to walk in a few days after the accident. In the latter class of cases there is probably an incomplete separation of the head at the epiphyseal line, or an impacted fracture with bending at the neck of the femur. In a number of cases the period of disability is short, and, as a rule, although there is slight deformity, there is usually a good functional result. At this period the neck of the femur in its altered angle is not able to stand the strain put upon it, and as a result there gradually occurs an increase in the disability, limp, pain, actual and apparent shortening, limitation of abduction, inward rotation, and flexion. The condition continues until resort is made to operative measures.

The Use of the x-Ray Photograph in Coxa Vara: The importance of examining all cases of coxa vara and those having a doubtful diagnosis cannot be over-estimated as a means of differential diagnosis. One having the requisite skill in interpreting the x-ray photograph will be materially aided in making a positive diagnosis of any abnormal condition of the upper end of the femur.

Hofmeister was able to make a differential diagnosis in six doubtful cases,

the x-ray photograph showing a curvature of the neck in three cases, and in the other three the neck was normal. In seven cases the diagnosis was confirmed by the x-ray photograph. In taking x-ray photographs notes should be made of the various angles used, as any change in the direction of the rays, position of the parts to be photographed, etc., will have a great bearing on the result.

In traumatic cases the x-ray photograph will make the diagnosis certain, and we will also be able to determine accurately whether the case is one of epiphyseal separation or a fracture through the neck. The photograph will also aid materially in determining the method of treatment to be pursued.

Treatment: If seen before the deformity has become far advanced, many cases, under proper conservative measures, will recover with good functional use of the limb. Patients should spend as much time as possible in the open air. Any exercise or position that throws the weight of the body on the involved part should be avoided. Constitutional diseases should receive the most careful attention. The tone of the thigh muscles should be improved by massage, bathing, active and passive exercises, and particularly should those movements be encouraged which tend to prevent an increase of the deformity. The patient may be allowed to go about with a properly fitting hip splint. If this line of treatment is persisted in, and the cases are seen early, many, at the end of one or two years, will have a perfect functional result.

In traumatic coxa vara (epiphyseal separation variety) the treatment should consist of extension in bed for a period of about four weeks, after which time the patient may be allowed up, in an ambulatory apparatus consisting of a plaster-of-Paris bandage fixing the hip and knee, supplemented by a traction hip splint (Whitman). This procedure removes the weight of the body from the involved leg, and at the same time sufficient traction can be used to overcome the muscular spasm. This apparatus should be worn two or three months.

In traumatic coxa vara (in which the fracture is at the neck of the femur) the treatment consists in forcible abduction and traction, on the principle that the fracture here is essentially of a green-stick variety, and that by forcible abduction the deformity in the neck of the femur is removed. While the limb is in this position of abduction, and while traction is being made, a plaster-of-Paris bandage is applied from toes to axilla. After a period of from six to eight weeks this bandage is removed and an ambulatory hip splint is applied and used for several months. The after-treatment consists of active and passive

exercises and massage. If these measures fail, we have recourse to operative treatment.

Operative Treatment: After conservative measures have been unavailingly used and loss of function and deformity have reached an extreme degree, we finally have to resort to operative treatment in all forms of coxa vara.

The methods of operative treatment are the following:

1. Forcible abduction. (Traumatic coxa vara.)
2. Sub-trochanteric osteotomy.
3. Resection of a wedge-shaped piece of bone from the neck of the femur.
4. Cuneiform osteotomy, or the removal of a wedge-shaped piece of bone from the shaft of the femur at the level of the trochanter minor.
5. Linear osteotomy of the neck.
6. Resection of the head and neck, leaving the trochanter major with the shaft.
7. Resection of the head, neck, and some of the great trochanter.

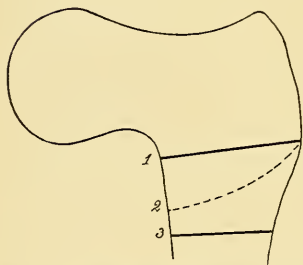


FIG. 340.—METHODS OF OSTEOTOMY FOR COXA VARA.

1, Intertrochanteric (Hofmeister); 2, curvilinear (Codivilla); 3, subtrochanteric (Lauenstein).

While all of the above operations have been performed from time to time by various surgeons, I have found that the following can be safely recommended:

1. Sub-trochanteric Osteotomy: One of the simplest means of correcting this deformity is by sub-trochanteric osteotomy. This was first suggested by Hofmeister, and first performed by Keetley, in 1888. This operation is readily performed by either the subcutaneous osteotomy or by the open method, the former being preferable. The osteotomy should be performed just below the trochanter minor. When the bone has been divided, it may be necessary, on account of the contraction of the abductor muscles, to do a tenotomy. The thigh is then rotated inward until the foot is in its normal position and the extremity is then carried to a position of marked abduction. A plaster-of-Paris spica bandage is then applied from the toes to the axilla. The plaster bandage is kept in place for from six to eight weeks and is then replaced by a Thomas hip splint. After the removal of the plaster spica the patient should be given careful massage, passive movements, and moderate extension. The result of this operation has been very satisfactory.

2. Cuneiform Osteotomy: This consists of the removal of a wedge-shaped piece of bone from the shaft of the femur at the level of the trochanter minor. Very often there will be found considerable restriction to abduction, due to contraction of the muscles or ligaments on account of the long-continued position in adduction. Before proceeding with the operation it will be necessary to overcome this contraction by massage, or a tenotomy may be necessary. The operation is performed as follows: A vertical incision about three inches long is made, beginning at the apex of the trochanter major and running downward. The bone is exposed, periosteum incised and reflected to either side, and a wedge-shaped piece of bone is removed from the shaft of the femur at the level of the trochanter minor. The upper line of section should be at right angles to the long axis of the shaft, the lower line of section should be in an oblique direction, the base of the wedge-shaped piece should measure from $\frac{3}{4}$ to 1 inch. The line of section should not cut the inner cortical surface of the bone. By not carrying the line of section through the entire bone the line of continuity is preserved and the liability of the slipping by of fragments is lessened. The deformity is then corrected by abducting the lower extremity, forcing the upper fragment, by means of the great trochanter against the acetabulum, using the lower portion of the shaft as a lever.

The lower extremity being in a position of marked abduction, a plaster-of-Paris spica bandage is applied from the toes to the axilla and left in place about eight or nine weeks. After this time union should be firm, and the patient may have a shorter plaster spica applied on a Thomas splint and be allowed to go about on crutches. By bringing the leg into its proper position the deformity is entirely corrected, the neck of the femur occupying its normal position in relation to the shaft.

3. Forcible Abduction: This procedure is often sufficient in those cases which are seen in the active state when the neck of the bone is soft and spongy and is capable of being forced again into its normal shape. It will be found that in a number of cases associated with rachitis, occurring in adolescence especially where the weight-carrying capacity is suddenly increased, there occurs this deformity, and this condition can often be corrected by forcible abduction. This is done by bringing the deformed neck of the femur against the upper border of the acetabulum while the head of the bone is fixed by the capsule and the shaft is used as a fulcrum. After the deformity has been corrected, which is determined by the normal range of abduction, the extremity

is fixed in abduction by a plaster-of-Paris spica extending from the toes to the axilla, for a period of from six to eight weeks. After this the joint may be fixed for a further period by a Thomas hip splint.

Coxa Valga. (Coxa Abducta.)

Coxa valga is the term applied to that deformity in the neck of the femur in which the angle formed by the shaft and neck is increased. This condition is rarely seen, and when observed is usually the result of injury, or may be found associated with congenital dislocation of the hip. From an anatomic view it is interesting in comparison with coxa vara. It may occur from disuse in childhood combined with traction, as in the illustration on page 403.

Spontaneous Dislocation.

In acute synovitis spontaneous dislocation of the hip sometimes occurs, there being usually a tendency thereafter to repeated luxations; these accidents from infectious synovitis, whatever the cause, being most frequently the sequels of rheumatism, typhoid fever, scarlatina, etc.

Paralytic dislocations from anterior poliomyelitis may be grouped under this head, the dislocation in this condition being due to the flail-like joint.

The treatment of dislocation due to acute synovitis would consist in early aspiration of the joint and fixation of the limb in an extended position, and subsequently the adhesions may perhaps be broken up. For the paralytic dislocation, an operation similar to the open operation of Hoffa for congenital dislocation of the hip would be indicated, and good results from operation have been reported by Carensky.

Fracture of the Neck of the Femur in Children.

Fracture of the neck of the femur—traumatic coxa vara—is not an uncommon accident, although until recently unrecognized. Whitman has observed twenty cases during the last nine years.

Fracture of the neck of the femur in childhood has markedly different symptoms from fracture in later life. The immediate results in childhood are much less disabling, and from the fact that the patient is frequently able to walk about within a few days after the injury, it may be assumed that in many cases there is a bending and breaking of the neck of the femur without an actual separation of the fragments. During the period of repair it may be mistaken for hip disease.



FIG. 341.—COXA VALGA.

The diagnosis is not difficult, and there is usually a history of injury. There is a shortening of the limb, motion is somewhat restricted, due to the contraction of the muscles, and the restriction is more marked in flexion, abduction, and inward rotation.

While the immediate effect in childhood is less marked, the deformity tends to increase in later years, and there may also be an actual shortening with permanent abduction.

The symptoms of joint irritation are usually combined with those of injury as a result of using the limb, and there may be marked sinking of the neck of the femur. In some cases the fact that the leg must always be flexed in an abducted plane is a source of annoyance, and causes much inconvenience in sitting.

Separation of the upper epiphysis of the femur in childhood is of very rare occurrence, the symptoms being elevation of the trochanter, crepitus, and eversion of the foot.

Treatment.—The first part of the treatment would be the same as that employed in adults, except that recumbency with suspension of the limb at right angles to the body will sometimes be found more satisfactory. In this connection the subsequent treatment of the condition is most important. The patient should wear a traction hip splint for at least a year after the recovery from the fracture of the femur.

Bursitis.

Enlargement and inflammation of the bursas about the hip-joint, non-tuberculous in character, occur as the result of injury. The gluteal and iliopsoas bursas are the ones most frequently affected. When the gluteal bursa is inflamed, it will be distinguished as an oval, fluctuating mass located beneath the gluteus maximus muscle. When the iliopsoas bursa is enlarged, it can be felt in Scarpa's triangle. The limb is flexed and slightly abducted.

In arriving at a correct diagnosis the possibility of hydatid cysts of the hip should not be overlooked, and the existence of lipomas of the hip as a possible condition should be borne in mind.

Treatment.—The treatment consists in incision and drainage. This should be accomplished by careful dissection, particular attention being given to avoiding the important structures in the vicinity.

Foreign Bodies in the Hip-joint.

While foreign bodies in the knee-joint are of common occurrence, they are rarely found to exist in the hip-joint. When they are found, they are of the same nature as those seen elsewhere, and result from loose pieces of cartilage or bone, fibrous exudate, broken osteophytes, metallic bodies such as needles, bullets, etc., and from hypertrophic synovial fringes. As the result of tuberculous epiphysitis I have observed the entire fragment lying loosely in the joint.

Treatment.—If these foreign bodies cause sufficient annoyance to require treatment, they should be removed by incision.

CHAPTER VI.

DISEASES OF THE KNEE-JOINT.

TUBERCULOUS KNEE-JOINT DISEASE.

Tuberculous knee-joint disease, or white swelling, is a chronic lesion of the knee-joint, beginning usually as an epiphyseal osteitis. As a rule, the condition is localized to certain portions of the epiphysis, the femoral or tibial being usually the seat of the primary osseous focus, although the lesion may begin in the head of the fibula or patella. The disease may terminate in recovery, ankylosis, or complete destruction of the joint.

Synonyms.—*English*, Strumous Arthritis; Scrofulous Disease of the Knee; Chronic Purulent or Fungous Synovitis of the Knee; Chronic Tubercular Osteitis of the Knee. *German*, Scrofulöse Gelenkentzündung; Fungöse Arthritis; Scrofulöse Caries; Tuberculöse Caries. *French*, Tuberculose Articulaire; Ostéo-périostite; Tuberculose Chronique. *Latin*, Tumor Albus; Fungus Articuli; Caries Sicca; Caries Mollis sive Fungosa.

The terms tumor albus and white swelling are the best established, but they do not indicate, as do the more modern terms, the pathologic character of the affection. For general use the term knee-joint disease, here employed, is useful and inoffensive, since it involves no etiologic or pathologic theory.

Etiology.

Tuberculous knee-joint disease occurs at all ages, but is most frequent in children and young adults. It is second in order of frequency, there being in 5680 cases of orthopedic disease treated at the Orthopedic Department of the University Hospital, Philadelphia, 104 cases of this affection. In 3820 cases of tuberculous joint disease treated at the Children's Hospital, Boston, during a period of twenty-five years, the knee-joint was affected in 104 cases, or 2.7 per cent. Taking the combined statistics of König and Gibney, in 1218 cases 57.6 per cent. occurred in males. In 704 cases of tuberculous knee-joint disease, König found that 292 occurred before twenty years, 190 between twenty and thirty years, 93 between forty and sixty years. Three forms, as in hip disease, may be distinguished, based upon the primary origin of the disease—femoral,

tibial, and arthritic. According to the experience of König, the primary synovial and osseous varieties are about equally frequent in youth, but there are three times as many osseous as synovial in adults. The investigations of Willemer*

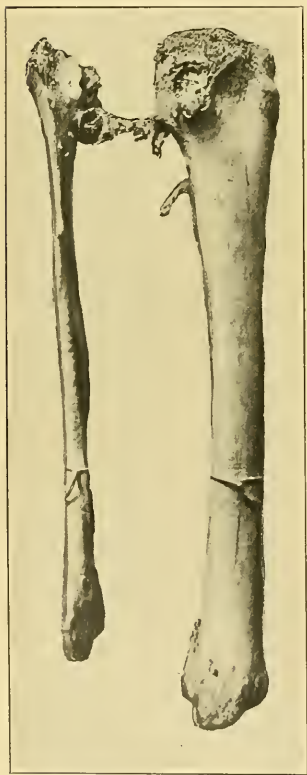


FIG. 342.—TUBERCULOUS DISEASE OF TIBIA AND FIBULA, UPPER END.

Kummer has reported a case of extirpation of the patella for primary tuberculosis of this bone.

cent., and primarily osseous in one or both articular extremities in 61 per cent.; between ten and twenty, synovial in 49 per cent., osseous in 51 per cent.; and above twenty years of age, synovial in 33 per cent. and osseous in 65 per cent. The extent and peculiar anatomic complexity of this articulation confer a peculiar chronicity upon all its diseases. The causes of knee-joint disease are both predisposing and exciting, and the remarks upon the etiology of hip-joint disease apply with equal force here. The predisposing causes are: age, sex, heredity, hygienic surroundings, social condition, and all those conditions which tend to deteriorate the general health. As exciting causes, traumatism and cold are more frequent than hip-joint disease, and primary synovitis, particularly in adults, is much more frequent.

Pathology.

The pathologic lesion is usually a chronic epiphysitis or chronic purulent synovitis. The primary focus may be in the femur, tibia, occasionally in the patella, and rarely in the head of the fibula. Kocher asserts that he has seen primary tuberculosis of the semilunar cartilages, and

* "Deutsche Zeitschr. f. Chir.," Bd. xxii, p. 268.

Tuberculous osteitis of the knee-joint may begin as a primary or a secondary focus. Its most frequent site is in an epiphysis, more frequently occurring



FIG. 343.

a, Caries of tibia and fibula; *b*, caries of tibia and fibula with ankylosis; *c*, caries of tibia.

in the internal condyle of the femur, next in frequency in the head of the tibia, then in the internal condyle of the femur, and rarely in the patella or head of the fibula.

König's report of 661 cases that came to operation showed the position of the primary focus as follows: Primarily osseous, 281; primarily synovial,



FIG. 344.—TUBERCULOUS DISEASE OF KNEE-JOINT, WITH ABSCESS, LATERAL VIEW (case of Dr. Nassau).



FIG. 345.—SAME, POSTERIOR VIEW.

266; and in 29 instances the situation of the primary focus could not be determined. Of the osseous form, the focus was in the femur in 93 cases, in the tibia in 137 cases, in the patella in 33 cases, and in 48 instances there were

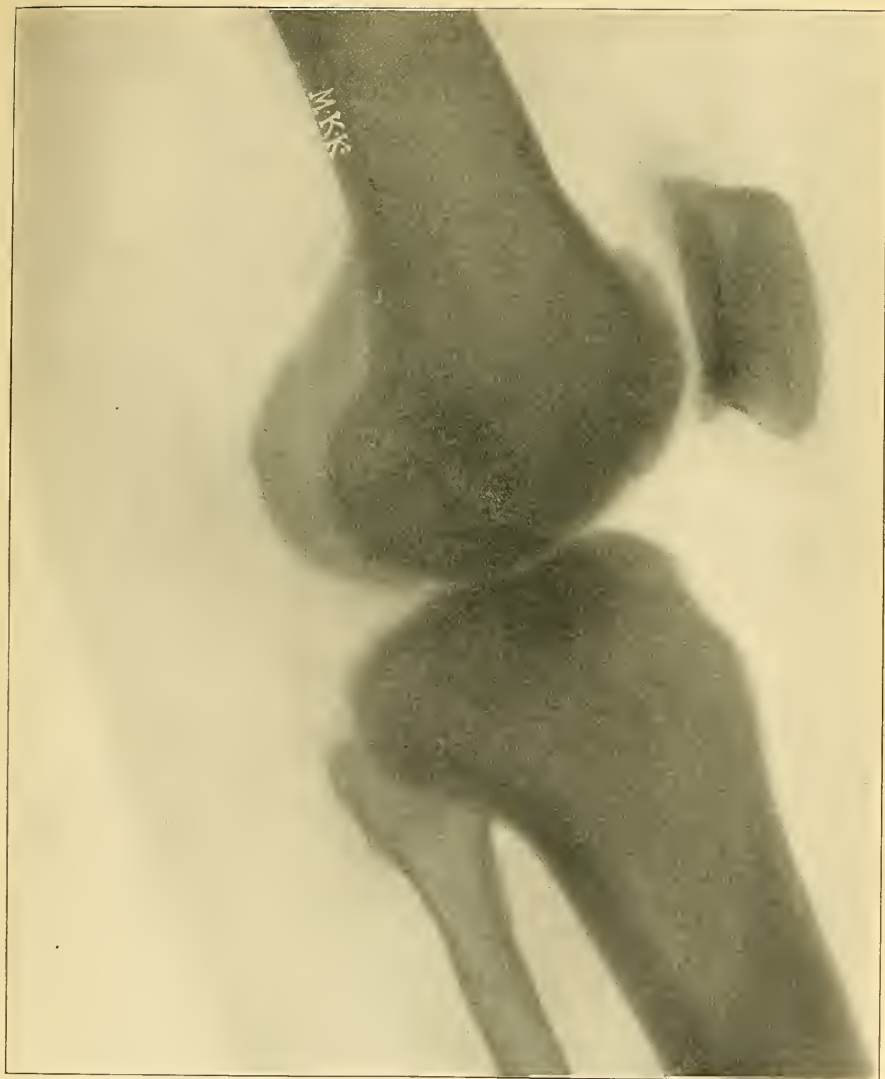


FIG. 346.—EXOSTOSES OF FEMUR, TIBIA, AND PATELLA FROM CHRONIC SYNOVITIS.

multiple foci. It is impossible to say definitely that the condition was synovial in 266 cases, as the entire joint was removed in only 92 instances. Of the 92 cases, the disease could be definitely stated to be primarily osseous in 50 instances, primarily synovial in 30 instances, and in 12 instances the position of the primary focus could not be determined. In 17 of the 50 cases the condition was primary in the femur, occurring in the internal condyle in 7 and in the external condyle in 6 instances, and in the other 4 cases the primary focus occurred in some other portion of the femur. In 17 cases of the 50 the primary focus was in the tibia, occurring in the internal tuberosity in 5 and in the external tuberosity in 5 instances; and in 7 cases the focus was found to be in some other portion of the tibia. The patella was primarily affected in 5 cases. In 11 cases it was supposed that the disease began in several places at about the same time.

The original focus may appear as a primary or as a secondary local affection. The focus may have its origin from the blood-current, the tubercle bacilli being carried to a favorable spot, forming in time a gray tubercle, which enlarges by the formation of tubercles into a large-sized focus usually of a rounded or elongated appearance. Or the focus may have its origin from a pre-existing tuberculous focus in some other part of the body. In this case a cheesy particle is carried by the blood-current from the primary focus, usually from the lung or bronchial lymph-gland, to the epiphysis, where it occludes a small vessel, forming a bony infarct having its apex toward the epiphyseal line and its base in contact with the cartilage of the joint.

In a number of cases the original focus occurs in the internal condyle and consists of a wedge-shaped area having its base directed toward the joint and its apex directed toward the epiphyseal line. This condition is known as a "bone infarct," and is considered by W. Müller to be due to a plugging of an artery in the epiphysis by a tuberculous embolus. He was able to produce this condition experimentally in animals.

Symptoms.

The symptoms of this disease, which is essentially chronic, can most suitably be discussed by classifying them under three stages: (1) an incipient stage, (2) an acute stage, and (3) a later stage.

This classification is practically identical with that of Mr. Adams, and attempts to give information as to the condition of the joint. First stage, from the onset to the formation of pus within the joint; second stage, from the end

of the first stage to the formation of abscess outside the joint; third stage, from the formation of abscesses to complete ankylosis or the death of the patient. It must, however, be remembered that the disease may terminate at any period and retrograde changes supervene.

These divisions correspond to: (1) Localized bone destruction; (2) supuration of joint contents; (3) reparative or destructive processes.

First Stage.—Beginning usually as an epiphyseal osteitis, its onset, as a rule, is very insidious. Following an acute synovitis, some months later, when the acute symptoms have disappeared, there may remain very moderate swelling, a limp, and a lessened function of the knee-joint, in those of a tuberculous tendency. This may be accompanied by slight pain or stiffness, attributed to growth or rheumatism. A limp or halt in walking, transient, recurrent, disappearing after a night's rest, marks the gradual onset of this grave malady. At this period examination of the knee will show some swelling about the joint, increase in fluid in the joint, a lessened distinctness of the normal prominences and depressions, with boggiess of the peri-articular structures, and perhaps a limp, some increase in the circumference about the knee-joint and tenderness, usually over the internal condyle. This condition may remain stationary for a number of months. Associated with these there may be an indisposition, a languor, an unnatural inactivity, and an indescribable something included in the comprehensive word *malaise*; or the general health may remain unimpaired.

With the destructive advance of the local process the symptoms assume a more positive character, and a decided limp, intermittent pain, swelling of the joint, discoloration of the skin, defective movement and muscular wasting, with marked constitutional disturbance, indicate the true character of the morbid affection and attract attention to the part.

Lameness: The slight limp observed in the early stage is due to the pain experienced on motion, and the efforts of the patient to diminish the shock of the impact of the foot upon the ground. Later the contraction of the knee, together with the impairment of motion and complete stiffness, produce a positive shortening and interference with free motion which are characteristic. In some instances an enlargement of one of the condyles, usually the internal, causing knock-knee, adds to the amount of disability and increases the limp.

Pain: The pain at first is paroxysmal and slight, of a dull aching and gnawing character, produced or increased by jarring. Later the suffering during the acute exacerbations is severe and excruciating. This is somewhat

diminished by the muscular spasm, by which the joint surfaces are held rigid, and motion is limited. Tenderness or sensitiveness on pressure is also present, the tender spot being usually on the internal condyle, about half an inch from the patellar edge.

Swelling: The tumefaction of the joint is characteristic—shapeless, uniform, obliterating the natural configuration of the part, filling the depressions of the sides of the patella—giving an indistinctness of outline and roughness of appearance that cannot be mistaken. Its consistence is soft, inelastic, and doughy, softer in some spots than in others. Unless the effusion be large, the patella is not floated up, as in the synovitis, but appears fixed in a soft gelatinous mass, or may even appear depressed from prominences upon either side.

Discoloration: Instead of the bright-red color typical of inflammation, the skin retains its natural hue or loses its color and becomes white, whence it has derived the name of “white swelling.” The surface is marked by blue, tortuous, superficial veins. This is due to the distention present causing the skin to be somewhat anemic.



FIG. 347.—ARTICULAR OSTEITIS (INTERNAL CONDYLE) (Barwell).

Heat: Elevation of temperature is also absent, and in some cases the part may present to the hand the impression of cold. Pyrexia is likewise absent.

Limitation of motion: Among the earliest positive symptoms the writer would lay particular stress upon this symptom. Preceding even the symptoms of local joint mischief, a limitation of motion, particularly in forced flexion and extension, is characteristic of osteitis. Or the joint may be held perfectly rigid in full extension or full flexion. In other cases there is a certain range of motion possible, beyond which muscular spasm occurs. This is due to a reflex tetanoid spasm, present in both the first and second stages of the disease, but increased during the exacerbations, and leading to the atrophy subsequently observed. It is most marked in the flexor muscles and produces the subluxations and complete luxations of the second and third stages.

Deformity: The first deformity to occur is in the line of *flexion*. This is caused by the fact that full extension is necessary in using the leg most advantageously. In this position the joint surfaces are in close contact, the ligaments

are tense and the synovial cavity is more contracted than when slight flexion occurs. As swelling of the condyle occurs accompanied by bogginess of the surrounding parts, sensitiveness of joint surfaces, and increased secretion of synovial fluid, the result is flexion with muscular fixation. This deformity favors that of *outward rotation*, which occurs when the limb is flexed and is supplemented by the pull of the biceps upon the head of the fibula. The next most frequent deformity is *backward displacement* of the head of the tibia; this



FIG. 348.—DOUBLE ARTHRITIS OF THE KNEE-JOINT.

is due to muscular action supplemented by local disease on the articulating surfaces, disorganization of the joint ligaments, and by attempts made at extension. *Genu valgum* occurs from primary increase in size of the internal condyle, from disorganization of the internal lateral ligaments, and from the use of the limb in the deformed position of flexion combined with outward rotation which favors abduction of the leg at the knee. In tubercular knee-joint disease flexion may be the only deformity present, or it may be combined with outward rotation, backward displacement, or genu valgum. A very rare deformity in tuberculous knee-joint disease is *hyperextension* of the tibia on the femur.

Phelps considers the deformities found in tuberculous knee-joint disease to be due to: (1) A voluntary effort

to relieve pressure and pain. (2) Involuntary spasm and contraction of muscles, which increase the deformity by advantage of the leverage due to flexion. (3) Nervous irritation of groups of muscles due to localized lesion in or about the joint. (4) Exceptional deformities are produced by pathologic detraction of bone or soft parts. (5) Outward rotation of the leg is produced by spasmodic contraction of the biceps after flexion has taken place. Flexion allows lateral and rotary motion at the joint.

General condition: Even in this early stage the expression is anxious,

careworn, and apprehensive; sleep is restless and disturbed, but without the sharp and sudden cry and pain to be noted directly; the appetite is capricious, the digestion feeble, the disposition irritable, and in every way the general condition denotes a local annoyance and physical distress that are harassing and debilitating to the constitution.

Second Stage.—As the disease progresses, the second stage is ushered in by night-cries and starting pains. The local pain changes its character, and abnormal movement, with joint crepitation and subluxation, muscular atrophy and abscesses, indicate the destructive nature of the pathologic process.

Night-cries: These starting pains are characteristic of bone mischief, and Barwell considers them to indicate commencing ulceration of cartilages. They are not so common as in chronic arthritis of the hip, and they occur usually when the child is first sinking to sleep. Their exact nature is uncertain, but they probably result from an unguarded twist, and the subsequent reflex muscular spasm.

Pain: In addition to the acute suffering experienced during the exacerbations, there is also present during this stage what Barwell has well described as “intra-articular tenderness,” and which he believes indicates that the articular lamella has given way, and the bone cancelli are open to the joint. It is a soreness, increased upon the slightest motion, and rendering the patient very apprehensive.

Abnormal movement: From intra-articular destruction the joint surfaces admit of motion in abnormal directions, eliciting also a grating or joint crepitus from friction of the exposed osseous surfaces. This must not be confounded with the posterior displacement of the head of the tibia upon the condyles of the femur, which, commencing earlier, may at this stage be excessive and amount to a subluxation or even to a complete backward dislocation. These are often associated, and indicate softening or destruction of the ligaments, and great intra-articular disorganization. Joint crepitus may, however, not be elicited, even though great destruction exist, from the luxuriance of the granulations filling the joint cavity.

True Lengthening and True Shortening: During the acute stages, on account of the proximity of the diseased area of the epiphyseal cartilage, there results an active hyperemia resulting in increased growth. This may take place in the epiphysis of the femur or the tibia, or it may occur in both. This accounts for the lengthening which is seen in the early stages of the disease and which in some cases varies from one-half to an inch. This lengthening

may continue to be present throughout the entire course of the disease. After the disease has been arrested there usually occurs ultimately true shortening, which is due to a retardation in growth of the side affected, so that finally this side is shorter than the well side. When the tuberculous process is very destructive there occurs considerable shortening, amounting to several inches in some cases. Of course, this accompanies extensive necrosis of bone.

Luesden, in observing 33 cases, showed shortening in 2, both sides equal in 18, and lengthening on the diseased side in 13. Berry and Gibney measured 116 cases of tuberculous knee-joint disease with reference to epiphyseal lengthening and found lengthening in 72 cases, or 62 per cent. Their observations were as follows: In 6 cases, lengthening 1 inch; in 15 cases, lengthening $\frac{3}{4}$ inch; in 34 cases, lengthening $\frac{1}{2}$ inch; in 17 cases, lengthening $\frac{1}{4}$ inch.

Taylor in examining the retardation of growth of the limb not only found marked lengthening and shortening of the femur and tibia, but also observed that there is general retardation of growth in all structures of the limb remote from the original site. Measurements were taken in 40 cases. He tabulated his cases according to the onset of joint symptoms into three classes: (1) those in which the disease had existed less than three years; (2) those in which the disease was at least three and less than five years; and (3) those in which the affection had begun more than five years previously. His classification is as follows:

CLASS I.

No.	SEX.	AGE.	SIDE.	DURATION, YEARS.	DIFFERENCE (INCHES).				
					Limb.	Femur.	Tibia.	Foot.	Patella.
1	M.	8	Right	$\frac{1}{6}$	==		==	==	==
2	M.	8	Left	$\frac{1}{2}$	==	$\frac{1}{2}$	==		
3	F.	4	"	$\frac{1}{2}$			==	$\frac{1}{2}$	==
4	F.	3	Right	$\frac{1}{2}$			==	$\frac{1}{2}$	==
5	F.	3	Left	$\frac{1}{2}$			==	$\frac{1}{2}$	$\frac{1}{8}$
6	M.	8	"	1			$\frac{1}{4}$		
7	M.	9	Right	1				==	$\frac{1}{4}$
8	F.	16	"	1			$\frac{1}{4}$		
9	F.	8	Left	1			$\frac{1}{2}$		
10	M.	5	Right	1				==	$\frac{1}{4}$
11	M.	8	"	1			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$
12	F.	3	"	1			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
13	M.	5	Left	1			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
14	M.	13	"	2			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
15	F.	13	"	2			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
16	F.	8	"	2			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
17	F.	3	"	2			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
18	F.	11	"	2			$\frac{1}{2}$	==	$\frac{1}{2}$
19	M.	12	Right	2			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
20	M.	9	Left	2			$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Average.					0.27	0.42	0.09	0.18	0.19

CLASS II.

No.	SEX.	AGE.	SIDE.	DURATION, YEARS.	DIFFERENCE (INCHES).				
					Limb.	Femur.	Tibia.	Foot.	Patella.
21	F.	10	Left	3	$\frac{1}{4}$	$\frac{1}{2}$	$-\frac{1}{8}$	$-\frac{1}{8}$	$-\frac{1}{8}$
22	M.	5	"	3	$-\frac{1}{8}$		$-\frac{1}{8}$	$-\frac{1}{2}$	$-\frac{1}{8}$
23	F.	3	Right	3	$\frac{1}{4}$	$\frac{1}{4}$	$=$	$-\frac{1}{4}$	$=$
24	M.	6	Left	3	$\frac{1}{8}$	$\frac{1}{2}$	$=$	$-\frac{1}{4}$	$-\frac{1}{8}$
25	F.	8	Right	3	$\frac{1}{4}$	$\frac{1}{4}$	$=$	$-\frac{1}{4}$	$-\frac{1}{4}$
26	M.	7	Left	4	$-\frac{1}{4}$	$=$	$-\frac{1}{4}$	$-\frac{1}{8}$	$=$
27	F.	7	"	4	$\frac{1}{4}$	$\frac{1}{4}$	$=$		
28	M.	8	"	4	$\frac{1}{8}$	$=$	$-\frac{1}{4}$		$-\frac{1}{8}$
29	M.	8	"	4	$\frac{1}{4}$	$\frac{1}{8}$	$=$	$-\frac{1}{4}$	$-\frac{3}{8}$
30	M.	13	Right	4	$=$	$\frac{3}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	
Average, ...					0.27	0.33	-0.11	-0.29	-0.17

CLASS III.

No.	SEX.	AGE.	SIDE.	DURATION, YEARS.	DIFFERENCE (INCHES).				
					Limb.	Femur.	Tibia.	Foot.	Patella.
31	F.	14	Right	7	$-\frac{3}{8}$	$-\frac{1}{8}$	$-\frac{1}{2}$	$-\frac{3}{4}$	$-\frac{3}{8}$
32	F.	9	Left	8	$\frac{1}{8}$		$\frac{1}{4}$	$-\frac{1}{8}$	$-\frac{1}{8}$
33	M.	9	"	8	$=$		$-\frac{3}{8}$	$-\frac{1}{4}$	$-\frac{1}{4}$
34	M.	16	"	8	$-\frac{2}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$
35	F.	9	"	8	$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{4}$	$-\frac{1}{8}$	$-\frac{1}{8}$
36	M.	14	"	10	$-\frac{1}{8}$				
37	F.	26	Right	10	$-\frac{1}{2}$				
38	F.	24	"	13	$-\frac{1}{2}$				
39	M.	21	"	17	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{2}{4}$	$-\frac{1}{2}$	
40	M.	45	"	42	$-\frac{3}{8}$	$-\frac{1}{2}$	$-\frac{3}{4}$	$-\frac{3}{4}$	$-\frac{1}{2}$
Average, ...					-1.4	-0.52	-0.091	-0.54	-0.33

He concluded that after osteitis of the knee the affected limb is nearly always longer during the first two years; generally longer in the following two years, and usually much shorter after seven years' duration, if the patient at that time had reached adult growth. This lengthening usually occurs in the femur and very often is noticeable within a few months after onset of the disease.

General condition: The constitution likewise suffers. Pyrexia, anorexia, sleepless nights, emaciation, and debility characterize the second stage of the affection.

Third Stage.—The third stage is marked by repair and ankylosis of the joint, or its total destruction, with hectic, exhaustion, and death from some visceral lesion.

Abscesses: Though abscesses may develop earlier, intra-articular and extra-articular suppuration is characteristic of the third stage. The pus does not find ready exit, and may open at some distance from the seat of the disease,

or after separating the integument from the underlying connective tissue will gradually open and discharge a quantity of ill-formed, ichorous pus, filled with flocculi.

Upon microscopic examination the pus was found by Koch, in two out of four cases, to contain *Bacillus tuberculosis*, and Schuchardt and Krause, at Volkmann's clinic, and Kanzler, Müller, Castro Soffia, Roswell Park, and others elsewhere have found them in still greater relative proportions. The importance of the direct association of tubercular osteitis and the tubercle bacillus cannot be overestimated. The course of abscess formation about the knee-joint,



FIG. 349.—PHOTOGRAPH OF CURED CASE OF KNEE-JOINT DISEASE, SHOWING CICATRIX.

from the anatomic peculiarity, is not so constant as in other localities. Femoral and tibial osteitis both tend to invade the joint. In femoral cases in which the pus does not enter the cavity of the joint, the abscesses find their exit in the inner side, near the epiphyseal juncture, or on the outer and anterior aspect of the external condyle of the femur. In tibial cases in which the joint is not primarily involved, the abscesses usually open upon the inner side over the inner tuberosity of the bend of the tibia. In arthritic cases the abscesses usually open by one or more sinuses upon the anterior inner surface of the joint, but in rare instances may open posteriorly in the popliteal space, or burrow long distances up or down the posterior aspect of the limb before opening. The

disease, however, may run its entire course without suppuration, or it may easily undergo cheesy degeneration and absorption, and caries sicca, identical with that found in the vertebrae and elsewhere, may be present.

Recovery.

If the tendency is to recovery with ankylosis, the gradual amelioration of all the constitutional and local symptoms—increased appetite, undisturbed sleep, reduction of temperature, improved circulation and better complexion, diminished suppuration, and the stationary condition of the local symptoms—indicates the change for the better. Tuberculosis in most cases, with proper

care and by paying attention to general treatment, is a self-limited disease. At any time in the three stages the process of repair may begin. Small tuberculous areas become absorbed or encapsulated. This usually occurs by the formation of fibrous tissue around the tuberculous area. Abscess cavities become replaced by fibrous tissue, caseous material is absorbed, and small pieces of necrotic bone are either encapsulated or remain at the bottom of a sinus until they are finally cast off. Bony, cartilaginous, or fibrous ankylosis may occur at the articular surfaces. The joint cavity may be greatly diminished or destroyed. In cases that have considerable deformity if uncorrected ankylosis with shortening, muscular atrophy, and fixation, marks the cessation of the morbid process in the joint.

Destruction.

As the disease advances, its destructive process is marked by an increase of all the symptoms; the patient becomes apathetic, the hectic is marked by greater ranges of temperature, the evening exacerbations are higher, complete anorexia, greater restlessness; scanty, albuminous urine; profuse night-sweats, and possibly diarrhea, lead to great exhaustion. Notwithstanding this formidable and melancholy array of symptoms, patients do not die of the joint affection alone, but of amyloid disease of the abdominal viscera (liver, kidneys, and spleen), from the excessive suppuration; or of other tuberculous affections, particularly meningitis.

Pari passu with these several retrograde general symptoms, the local disease is making rapid progress toward the total destruction of the joint. The joint increases in size and softness, the muscles atrophy greatly, the bones become more movable or are completely luxated, the skin over the parts desquamates in large flakes, and the sinuses become filled to overflowing with luxuriant granulations.

Diagnosis.

The general diagnostic signs of tuberculous osteitis of the knee-joint are intermittent lameness, paroxysmal pain, general rounded swelling, heat over the joint, and a tender spot on pressure to the inner side of the patella, with limitation of motion and atrophy. The two last symptoms are peculiarly significant of osteitis, and upon them the writer places most reliance. Being a reflex tetanoid spasm, it appears very early, in some cases even before much intra-articular mischief has been set up, or, in other words, while the disease is still confined to the epiphysis or epiphyseal cartilage.

Later, the character of the swelling, the location of the tender spot, and abscess formation, with night startings and cries, render the diagnosis certain. But for treatment to be efficient, it is essential that an early diagnosis be made, and as direct aids to this, great stress should be placed upon the two cardinal symptoms before referred to.

Differential Diagnosis.

Tuberculous osteitis must be distinguished from synovitis, rheumatic and suppurative arthritis, gonorrheal arthritis, arthritis deformans, periarthritic disease, hemophilia, acute infectious epiphysitis, Charcot's disease, sarcoma, injury to the knee-joint, and neuromimesis.

Synovitis.—It is with this affection, particularly in the earlier stages, that tubercular osteitis is most frequently confounded, and if subacute and without effusion, it is difficult or impossible to distinguish between them. It is chiefly upon the character of the swelling (the effusion) and the reflex symptoms that the differential diagnosis rests. If the *swelling* in synovitis be large, the patella, by pressing upon it, can be depressed until it is felt to strike against the bone; and on relaxing the pressure it floats up again upon the fluid within the joint. Fluctuation, too, may frequently be detected. In osteitis the swelling is soft, inelastic, and doughy, filling the sides of the patella and fixing it immovably. The localized pain, the reflex spasm and atrophy, are all absent in synovitis, and motion is often in the latter but little impaired.

Acute Rheumatic Arthritis.—This affection, which partakes of the nature of an acute synovitis, is characterized by the sudden onset, the local manifestations being preceded by pyrexia, the association of other joints, localized edema about the affected joints, and the acute, essentially pyrexial nature of the disease.

Suppurative Arthritis.—Acute purulent arthritis, as a complication of traumatic infective fever, resembles the tuberculous osteitis in its destructive nature and the presence of chills, fever, sweating, progressive emaciation, and loss of strength, as it also does in the local symptoms; but it is readily distinguished from the latter by the rapid course, the association with traumatic fever, and by the character of the suppuration, which contains the bacteria of the acute infective processes, and does not contain the bacillus of tuberculosis.

Gonorrheal Arthritis.—Gonorrheal inflammation of the knee-joint very often resembles certain cases of tuberculous disease; this is especially so, as the history is often concealed. If the case is seen during the acute attack the

acuteness of the symptoms, combined with the signs of inflammation about the joint, high temperature, and presence of a gonorrheal infection elsewhere, will contribute toward a diagnosis. In gonorrheal inflammation the induration about the joint is more dense and the limitation of motion greater than in tuberculous disease. This limitation of motion is due to mechanical causes and not to muscular spasm. By giving an anesthetic the rigidity due to muscular spasm will disappear, that due to induration about the joint will remain.

Arthritis Deformans.—This affection, particularly that division known more accurately as osteo-arthritis, resembles the tuberculous osteitis in the character and location of the pain, in the contraction and limitation of motion, and the enlargement of the joint and the muscular wasting. Moreover, it may occur at any period of life. It is, however, to be distinguished by the synovial character of the tumefaction, by the absence of fever, rigors, sweating, suppuration, and muscular spasm, and by the roughness of the crepitation, the participation of other joints, and its predilection for mature and advanced life. The muscular wasting is the atrophy of disuse.

Periarthritic Disease.—Periarthritic or peri-articular abscesses and inflamed bursæ are to be distinguished from the graver affection by the position and fluctuation of the swellings, their relation to the patella, the entire absence of muscular spasm, atrophy, joint stiffness, and constitutional disturbance.

Hemophilia.—Very often this condition resembles tuberculous knee-joint disease, but the rapid onset, the history of bleeder's diathesis, the absence of inflammatory signs, and often the presence of localized areas of hemorrhage in other parts of the body will distinguish the former from the latter condition.

Acute Infectious Epiphysitis.—This is usually of sudden onset, at times there may be the presence of some infectious foci elsewhere, there are local inflammatory signs, accompanied by marked constitutional disturbances.

Charcot's Disease.—In this disease there develops suddenly an effusion into the knee-joint; this is followed by firm edema, reaching from the ankle to the mid-thigh, rapid destruction of the joint accompanied by no inflammatory signs, no muscular spasm, and is usually preceded by some disease of the spinal cord.

Sarcoma.—This condition may be confounded with tuberculous knee-joint disease, as its favorite site is the lower epiphysis of the femur. The former is more rapid in growth, is more localized, the joint is freely movable, the diagnosis is often facilitated by spontaneous fracture. An early diagnosis can be made by means of the α -ray photograph, which shows the destruction

of bone to be greater in sarcoma, while in the tuberculous process there is usually involvement of the joint. The latter condition yields more readily to treatment.

Injury to the Knee-joint.—Synovitis accompanied by pain, slight limp, and flexion following strains of the knee-joint are common. At times there is no history of injury. The condition is to be differentiated from tuberculous conditions by sudden onset and by it yielding quickly to treatment. The fact, however, should not be lost sight of that tuberculous joint disease often follows apparently simple synovitis of traumatic origin.

Neuromimesis.—Functional or hysterical joint disease occurs most frequently in young females of the upper class, and usually in those of a pronounced brunette type. This pseudo-arthritis can, however, readily be distinguished from the genuine disease by the absence of swelling, redness, atrophy, or muscular spasm, by the superficial but exaggerated nature of the pain, the suddenness of the attack, and the fact that the appetite and general condition are not affected. Moreover, the position of the limb is unchanged, and there is no tendency to suppuration. The limitation of motion disappears under mental emotion, and its free motion is not then accompanied by increased pain.

Prognosis.

The prognosis in knee-joint disease is, in general, more favorable than in the same affection in the larger joints, the termination depending upon the early recognition, the social condition and general health of the individual. A good nutritive condition is the most important point for a favorable prognosis, which would not be very greatly affected even by early and extensive suppuration. Where treatment is instituted early and faithfully carried out, recovery may be anticipated in the milder cases. Where much destruction exists, ankylosis may supervene, with flexion, subluxation, or permanent distortion of the joint in an unfavorable position for locomotion. In severe cases flexion is the rule, often even when treated with the greatest care. When not arrested in its early stage, the course is apt to be very chronic and suppuration profuse from the vast extent of the synovial envelop, and the presence of the semilunar cartilages, which likewise undergo liquefaction. In the severest grades of the affection complete destruction of the joint results without ankylosis and renders excision or amputation necessary. Slight swelling of the joint, with great pain and early muscular atrophy in anemic children, but with little or no suppuration,

indicates primary disease of the bone, and renders the prognosis very bad. In mild cases, even after recovery, protection will be necessary for a considerable period.

Treatment.

The treatment of tuberculous knee-joint disease may be classed as constitutional, conservative, and operative.

Constitutional Treatment.—This will include all therapeutic, hygienic, and other measures calculated to invigorate the system. Anything contributing toward the improvement of the general health often favors spontaneous cure and lessens the percentage of operative cases. Hygienic surroundings should be carefully considered. Patients should be kept in the open air during the day and a great portion of the night. Frequent bathing and plenty of good food are essential. The general condition should be improved by tonics, as cod-liver oil, iodine and its preparations, hypophosphites, iron, arsenic, and all remedies which will build up the general health.

Mechanical Treatment.—The mechanical treatment consists in fixation and protection by means of apparatus. During the acute stage the patient should be confined to bed, and at the same time some means of fixation and traction should be employed. Fixation should be used until all signs of local inflammation have subsided and any tendency to displacement is absent. Protection should be continued for a much longer period.

Fixation is secured by splints consisting of plaster-of-Paris, silicate of soda, leather, celluloid, hatter's felt, poro-plastic felt, papier mâché, wood, etc. In the application of these splints they should extend from the ankle to the perineum, and whenever possible should be used only temporarily until a proper splint, which will fix the entire thigh and hip-joint, can be obtained.

Plaster-of-Paris splints are applied as follows: the leg and thigh are covered with roller bandages of sheet-wadding, from the ankle to the perineum, a strip of tin 5 centimeters in width, reaching the entire length of the leg, is placed in the anterior median line, and plaster-of-Paris bandages are applied uniformly from ankle to perineum, making about six layers. When the plaster has set, it is cut anteriorly, using the tin strip for a guide. The tin strip is then removed.

Plaster-of-Paris splints are easy to make, harden quickly, and in cases of muscular spasm and slight flexion successive ones can be applied weekly until the leg is straight and spasm has disappeared. At times it may be necessary

to apply the bandage under anesthesia, especially in cases of long standing in which there is considerable flexion present.

Plaster-of-Paris is also used in making permanent splints of silicate of soda, leather, celluloid, felt, wood, paper, etc., a splint of plaster-of-Paris being first made, from this a model of the leg, and on this model is built a molded splint of other materials.



FIG. 350.—AUTHOR'S HATTER'S FELT KNEE SPLINT.

In all cases where a fixation apparatus is used and locomotion is employed, protection is furnished by means of axillary crutches and a high shoe upon the sound foot, which allows the affected side to swing clear of the ground. Better protection is afforded by means of some splint which has a perineal support and extends below the foot; this form of splint relieves the knee from all jars and strains during locomotion.

Of the more elaborate splints used, some of which combine traction with fixation and protection, are Thomas's, the caliper, Sayre's, Billroth's, Shaffer's, Roberts's, the author's, and Taylor's knee-splints.

Thomas's knee-splint consists of an ovoid iron ring encircling the thigh at the perineum, from which two iron rods pass down the side of the leg to a metal plate several inches below the foot, so that the toe of the diseased limb may be fully one inch short of reaching the ground. In measuring for the splint, the length of the outer bar is taken from midway between the crest of the ilium and the top of the great trochanter, to three inches below the sole of the foot. The circumference of the thigh at the groin is taken, allowance being made for padding. A patten must be worn upon the sound limb, and the apparatus must be suspended by a strap over the shoulder of the sound side, attached posteriorly to the ovoid ring and buckled anteriorly. Any blacksmith and saddler can construct the splint from the following directions: The upper crescent is formed of an iron ring three-eighths of an inch in thickness, varying



FIG. 351.—AUTHOR'S CELLULOID SPLINT FOR KNEE-JOINT DISEASE.

according to age and weight of the patient. It is nearly ovoid in shape, covered with boiler felt and basil leather, and attached to the inner rod at an angle of 55 degrees, which, when correctly padded, becomes reduced to 45 degrees. To support the limb, an apron of basil leather is stretched across the two bars, and in the leather are two slits for the insertion of the bandage by which it is applied. It is customary in this country to secure the apparatus to the limb by two broad bands of leather, either buckled or laced anteriorly. Traction may also be applied by utilizing the metal sole-piece, but the use of traction is not in accordance with the views or practice of the inventor of the splint. The side bars may also be made adjustable by a simple hollow tube and bar arrangement, in case it should be desirable to lengthen or shorten the splint. The Thomas splint not only fixes and protects the joint, but retains it during the progress of reduction of any deformity.

The caliper knee-splint. This is made from the Thomas bed splint by marking two points on the end of either bar, one point being an inch below the sole, the other two inches below; the loop is cut off at this point and the bars are bent inward at right angles by a suitable instrument. The bent ends are fitted into a tube in the heel of the shoe; the latter should be cut to prevent abrasions of the heel. The splint can be applied after straightening under anesthesia or used for gradual correction. In walking the patient's heel is about one inch above the inside of the shoe. The leg is held immovable by leather bands beneath the knee and calf and graduated pressure is made just above and below the knee by bandages, leather bands, or metal shields. This splint can be used to retain the corrected position obtained under anesthesia for graduated pressure to overcome flexion.

The Sayre knee-splint was designed by its distinguished inventor to keep the knee-joint in a state of absolute rest and extend the parts so as to remove all pressure from the articular surfaces. As a fixation splint it serves an excellent purpose, but it can hardly be admitted at this time that it is capable of separating the joint surfaces. What it probably does, however, is to overcome reflex muscular spasm, which is such a destructive element in this affection. It consists of "two sheet-iron bands or collars, connected by two bars so constructed that they can be made longer or shorter, as required. The bands

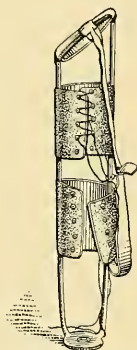
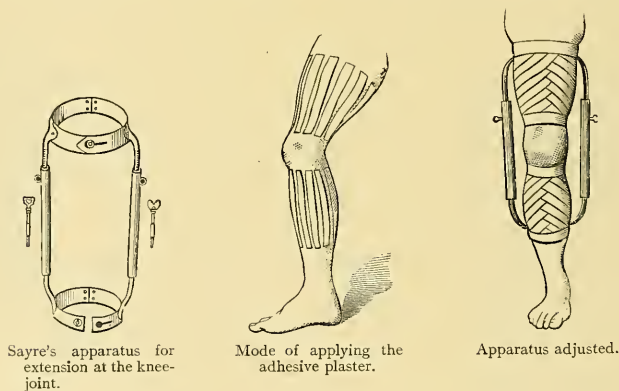


FIG. 352.—THOMAS KNEE-SPLINT.

are about an inch in width, have a joint behind, and slots and a pin for fastening in front. The hinge-joint at the posterior portion of the band that is to surround the *leg* is made by cutting straight across the band, and then fastening the pieces in the proper manner for forming a joint. The hinge-joint at the posterior portion of the band that is to surround the *thigh* is made by cutting out a V-shaped piece, and then fastening the pieces in the proper manner for forming a joint. This V-shaped piece is removed for the purpose of securing a smaller circle at the lower edge of the band than at the upper, which will better adapt it to the natural tapering shape of the thigh. The band which surrounds the leg should be immovably attached to the side-bars. The band



which surrounds the thigh should be attached to the side-bars in such a manner (by a single rivet or hinge) that it can be tilted about at pleasure, which permits the use of the instruments when the leg is flexed upon the thigh at a slight angle. The bars which connect these bands or collars are divided into two pieces, one of which carries the cog and the other the ratchet, by means of which extension is to be made. The ratchet is moved by means of a key, and in this manner any amount of extension desired can be readily obtained.”*

The Billroth splint. This splint is frequently used in overcoming persistent deformity. During its use patients should be kept under observation, as it is liable to cause sloughs. All points of pressure should be carefully padded,

* Sayre: "Orthop. Surg.," ed. 1883, p. 210.

and in addition pads of felt or similar material should be placed in front of the condyles of the femur and behind the upper end of the tibia. A plaster-of-Paris bandage is applied from the toes to the groin and is made purposely thick in the popliteal region. In the bandage two joined iron strips attached to broad tin plates are incorporated at the knee-joint, the point of junction of the strips being just above and in front of the joint. After the plaster has set, the front over the knee is cut out and a transverse cut made in the posterior aspect. By inserting wedges of increasing sizes the edges of the cut are separated and the knee-joint gradually extended. This splint has a slight

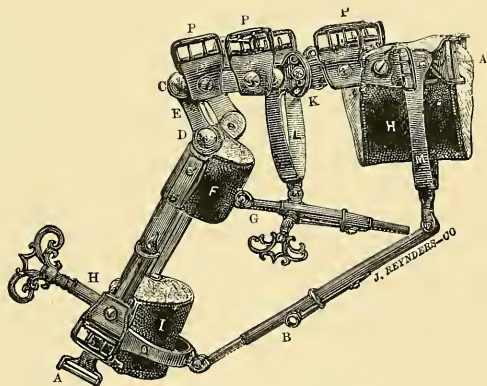


FIG. 354.—SHAFFER'S KNEE SPLINT.

tendency to overcome any subluxation that may be present. On account of the great pressure which it exerts its use should be carefully watched.

The Shaffer splint. The ingenious apparatus of Shaffer (Fig. 349) is designed to apply the desired force directly to the head of the tibia, throwing the same forward and downward by a simple movement. The force applied to overcome the muscular contraction is in a direct line with the deformity, and the effect is to relieve joint-pressure and correct the deformity simultaneously. The apparatus is thus described:*

"It consists of three parts—the thigh, leg, and intermediate. The first two are secured to the limb by adhesive plasters, which are attached at the points A A. Extension is made with a key at the extension rod proper at B.

* "On Reflex Muscular Contraction and Atrophy in Joint Disease," "Archives of Clin. Surg.," June, 1887.

The joints at C and D move upon pivots, and as the extremities of the apparatus are secured by their adhesive straps at A A, the joint D moves forward and downward, describing a circle, the radius of which is the bar E. Pressure is thus made directly upon the head of the tibia by the band F, and this can be very greatly augmented by using the extension rod at G, which further relieves the joint of pressure by additional extension in the position already acquired by the preliminary extension of the rod B. H is an accommodation—not properly an extension rod—which glides forward as the extension is applied at B. As soon as the leg is thrown sufficiently forward the accommodation rod is secured by a slide, and an extra turn of the key at B and G leaves the joint free from pressure, and with adequate extension applied directly to the contracted flexors. The thigh and leg bands at H and I move upon pivots, so that they adjust themselves readily to any position, and at K there is an arrangement by which the curved bar L may be adjusted to suit the requirements of the extension rod B. The bars M and O are secured to the thigh and leg parts by double rivets. Through the buckles at P P P webbing straps (padded) are passed, producing counter-extension in addition to that secured by means of the adhesive straps."

This apparatus gives most perfect fixation and extension to the joint, relieving intra-articular pressure, overcoming muscular contraction, and correcting deformity. It requires skill in its application and constant attention on the part of the surgeon or attendant, and is not, therefore, adapted for general extensive use.

The Roberts brace. The same may be said of the Roberts* brace, which is the one the writer prefers and employs where the patient or institution can afford the more expensive apparatus. It consists of two light steel troughs padded or coated with rubber, that are firmly secured to the limb by encircling bands of surgical webbing, affording absolute fixation to the joint when the extending rods are locked after adjustment. Three ratchet extension bars arranged in the form of a triangle are placed posteriorly, corresponding to the long axis of the limb. This enables the surgeon to produce extension, to overcome flexion and the tendency to the production of deformity, the extension rod B acting directly upon the head of the tibia and parallel with the line of contraction of the flexor group of muscles, and not low down on the tibia, as in the popular Stromeyer's splint, and all splints constructed upon that faulty mechanical principle. Moreover, force applied below estab-

* "Trans. Med. Soc. of Penna.," 1884, p. 408.

lishes a fulcrum at the surface of the diseased joint, thereby increasing the disease. In this splint the long extension rod *C* is used only as a compensating bar, adjusting the angle of the splint to the angle of the flexion of the limb. The power for restoring the head of the tibia and overcoming the spasmodic contraction of the flexor muscles is applied with moderation directly in the axis of their contraction. Through the extension bar *B* (Fig. 350) the head of the bone describes in its restoration the arc of a circle. The compensating bar in correcting the angle of flexion carries the limb through the arc *C* to *D*, having a center in the end of the femur. Mechanically this arrangement of force, as Dr. Roberts remarks, corrects the deformity and relieves, by extension, the reflex spasm of the flexor muscles without crowding together the dis-

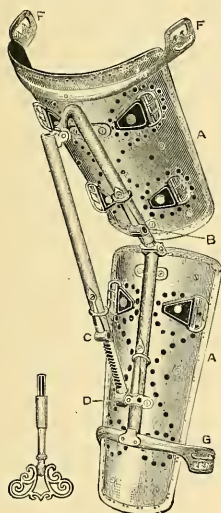


FIG. 355.—ROBERTS'S EXTENSION KNEE SPLINT.

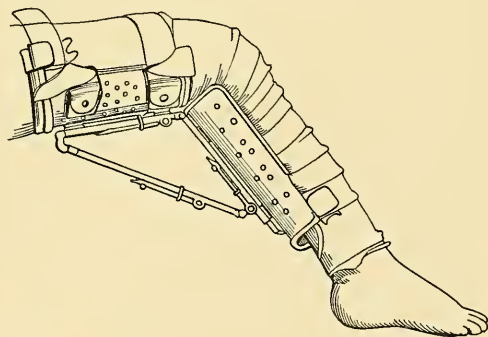


FIG. 356.—ROBERTS'S EXTENSION KNEE SPLINT APPLIED.

eased joint surfaces, or aiding in subluxating the head of the tibia, as would be the case should the limb proper be used as the long arm of our lever, with the insertion of the hamstring tendons, instead of the normal center of motion of the joint, as the center of motion of the splint. Supplementing the direct extension upon the contracted muscles, another bar *D* has been added to aid in steadying the joint and relieving intra-articular pressure. The splint acts upon the limb through adhesive plaster applied above and below the joint, to which surgical webbing has been attached. This webbing is firmly secured to the counter-extending band *F*, and to the extension rod *G*, affording a means of direct extension always corresponding to the angle of flexion. The extension

bars are controlled by a key and ratchet movement, held in place, after adjustment, by a small ring and pin.

This splint meets all the indications better than any apparatus with which the writer is familiar, and enables the patient, by means of crutches, to enjoy all advantages of exercise in the open air. It overcomes reflex muscular spasm, relieves joint pressure by making extension in the line of deformity, and fixes the articulation in the most favorable position for recovery. The author's knee splint is similar to Roberts's, but simpler in construction.

A very useful walking splint, and one highly recommended by Bradford and Lovett, is one similar to that described under hip disease as Taylor's protection splint. It consists of a long outside bar provided with a perineal band above, a lock-joint at the knee that can be set at any angle, and an extension bar below the foot. Application of the splint is made with adhesive plasters and surgical webbing, attached above to the splint and below to the extension bar. The knee-joint on the splint is set at an angle corresponding to the angle of deformity, extension is made, and the splint secured to the limb by leather lacings.

Supplementary Treatment.—In connection with mechanical treatment there are many local measures in use which often prove of great value. Some of the local measures are: Tincture of iodine, cantharidal collodion, Paquelin cautery, x-ray, compression with adhesive plaster, mercurial and silver ointments, injections of iodoform emulsion, carbolic acid, and passive congestion.

Tincture of iodine may be used locally in repeated applications. Tincture of cantharides may be used in the form of cantharidal collodion, cantharidal plaster, or the tincture itself may be used.

The Paquelin cautery may be used either locally on the skin or in more severe cases can be introduced directly into the bone tissues softened by osteitis. This has a beneficial effect by promoting the development of cicatricial granulation tissues.

The use of the **x-rays** has of late been tried with beneficial effect and does good by increasing the amount of blood to the part, thereby stimulating granulation tissue, which in time forms cicatricial tissue.

In some cases much improvement is obtained by compression with adhesive plaster, flannel, and rubber elastic bandages.

The following **ointments** are used by the author: Ichthyol ointment, 40 per cent. strength; compound iodine ointment; mercury and belladonna ointment (ung. bellad. ʒj, ung. hydrarg. ʒiij). Billroth recommended

a strong ointment of nitrate of silver (5j to 3j) rubbed into the joint. The injection of iodoform emulsion has often been followed by very favorable results. In cases of moderate synovitis the fluid may disappear rapidly and permanently. Improvement usually follows the first injection; if none occurs after the fourth or fifth, the injections should be discontinued. A sterilized aspirating needle is used. The point of injection should be at the outer side of the patella at its upper border or over the most prominent portion of the swelling. The fluid in the joint is withdrawn and 5 to 10 c.c. of a 10 per cent. sterilized emulsion of iodoform in glycerin or oil is injected according to the age of the patient. The wound is sealed by collodion or appropriate sterile dressing. Injections may be repeated every ten to fourteen days. König, after washing out the joint with a 2 per cent. solution of carbolic acid, injects a 5 per cent. of the same solution. He claims very good results from its use.

Passive congestion—Bier's method. This consists in applying a rubber bandage above the knee-joint sufficiently tight to check the venous flow, and from the toes to just below the knee a tight flannel bandage is applied. This method is used for one to two hours until it is well borne, and then may be used all day. It should be removed at night. The injection of iodoform emulsion may be used in connection with it. Its use is contraindicated by the presence of abscesses. It is supposed to do good by increasing the amount of blood to the part, thereby forming granulation into fibrous tissue. Mikulicz claims for it the special advantage of rapid subsidence of the pain in very painful joints. At present its use is limited and it should be employed only under careful observation.

Treatment of Complications.

The complications requiring special treatment are deformity and abscess.

Deformity.—Flexion of the knee is an early and persistent complication of knee-joint disease. It occurs at two separate periods of the affection, as a painful symptom of the early acute stage, and as an insidious, painless complication of the later stage. The means required for straightening the knee will differ at these two periods, and may be classified into: (1) Repeated fixation in plaster-of-Paris splints. (2) Traction. (a) Recumbent, (b) ambulatory. (3) Gradual forcible extension. (4) Rapid forcible extension. (5) Supracondyloid osteotomy. (6) Resection of the knee-joint.

1. **Repeated fixation in plaster-of-Paris splints.** A very simple and inexpensive way of correcting the deformity is by means of plaster-of-Paris ban-

dages applied at intervals of one week. These bandages should be applied from the toes to the groin. All bony prominences should be protected; slight correction that does not cause pain may be used. It will be found that in applying successive bandages the muscular spasm has decreased to such an extent that full extension is possible without causing pain. During the process of extension the patient must not bear any weight on the foot, and very often the patient will improve more rapidly if kept at complete rest in bed.

2. Traction. Traction should always be made in the line of the deformity. (a) Recumbent traction by weight and pulley, which can be applied below the knee by adhesive plaster. The leg should be supported upon a pillow, a posterior angular splint, or may be suspended in a suitable apparatus. The foot of the bed should be raised to secure counter-extension. The weights used should be very light, only sufficient to steady the limb. As the muscular spasm and flexion decrease the limb can be gradually placed in full extension. After all sensitiveness and pain have ceased the patient may be allowed up on crutches after some ambulatory apparatus has been applied. (b) Ambulatory traction may be used from the beginning. One of the best traction splints is the one modified by Dr. Lovett. The splint consists of two uprights, one inside and one outside, joined at the knee. On the outer upright at the top is an arm to carry a perineal band and to furnish counter-extension. At the bottom of the upright is a windlass, to which may be attached the extension straps running from the knee downward. Counter-extension is also furnished by adhesive straps attached to the top of the splint. At the knee, by means of a disk and screws which control the various holes, the splint can be set and held at any angle. The splint is held in place by leather bands passing around the thigh and calf. The splint can be used with crutches and a raised sole on the other foot. It can be used as a simple walking splint without crutches and with a slight high sole on the sound foot; and during convalescence the windlass and extension can be omitted, the ends of the uprights fitted to a shoe, and the splint used for protection.

H. L. Taylor uses a traction apparatus in which extension and counter-extension are made by adhesive plaster which is attached to straps. This is surrounded by a plaster-of-Paris splint, to the ends of which the traction straps are attached. Crutches and a high sole on the sound side complete the apparatus.

The splints of Dr. Roberts and Dr. Shaffer, described previously, are also used. Whatever splint is used, it should be such that traction can be made in the line of the deformity, overcoming the flexion and subluxation without estab-

lishing a fulcrum at the surface of the diseased joint, which is always the case when force is applied at a distance below the insertion of the resisting flexor muscles.

3. **Gradual forcible extension.** This may be applied by means of the Thomas knee splint, the Billroth splint, Stillman's sector splint, or the caliper splint. In employing the Thomas knee splint to correct deformity, the roller bandage is firmly applied in front of the thigh and knee and behind the calf. The more firmly these are applied, the greater the pressure that is exerted, and great care must be taken lest an acute exacerbation be excited from improperly applied force.

The Billroth splint is a simple and very efficient method of applying plaster-of-Paris extension. It consists of a plaster bandage applied to the limb, in which at the knee are incorporated two hinged iron strips. The bandage is made thicker under the knee, is allowed to harden, and a window is cut above over the knee, and below, beneath the knee, a transverse division of the plaster is made. Into this slit wedge-shaped pieces of cork of increasing size are daily inserted, until the knee is straight. Extension must not be begun before twenty-four hours. The writer is personally familiar with its application in Prof. Billroth's clinic in Vienna, where its excellence has been fully tested in many cases. The force exerted is great, and the splint must be carefully watched. There is no better appliance for public charity use. In both the Thomas splint used for extension and the Billroth splint the power is applied upon the erroneous mechanical principle of the popular Stromeyer splint, *i. e.*, the power is applied low down on the tibia, establishing a fulcrum at the surface of the diseased joint and exerting injurious pressure upon the diseased surfaces. Stillman's sector splint is open to the same objection. For retention after extension, the sector splint of the author will be found useful and inexpensive. Instead of the simple free, or locked joint, a sector is added to one arm of the joint, which enables it to be refixed at any angle by a set-screw. A large leather knee-pad secured by straps and pins extends and fixes the knee-joint. A considerable amount of pressure may likewise be exerted. The cut (Fig. 454) sufficiently explains the details. The caliper splint has been described above.

4. **Rapid forcible extension—*redressement forcé*.** This should not be employed in the early stages or in acute cases, but where firm fibrous ankylosis exists, this will be found to be the most efficient method of overcoming deformity. Manual force will be sufficient in the majority of cases, and powerful mechanical appliances should be avoided if possible. The knee should first be forcibly

flexed and then forcibly extended. All contracted tendons and fascias should be freely divided, open incision being the best method in this situation. A free incision across the popliteal space allows ample inspection, and in this manner rupture and division of the popliteal artery may be avoided. Fracture of the femur and separation of the epiphyses may also be avoided with proper care, but should they occur, they do not necessarily increase the gravity of the prognosis, and their cure will be effected by the subsequent fixation requisite to treatment. If a mechanical appliance is required, the best will be found to be Goldthwait's genuclast. Its action is thus described: Pressure forward on the head of the tibia is exerted by turning the handle; this, by means of a screw-force, pushes the plate forward, working through the band. The calf muscles protect the artery and nerve from injurious pressure. Counter-pressure is secured by means of leather straps, which are passed respectively over the knee and leg, protected by a thick layer of saddler's felt. Several straps will be needed at the knee to prevent loss of counter-pressure as the limb is made straighter. Another strap, under the leg, secures the lower part of the leg. The side-bars, bands, and plate of the apparatus should be of strong steel. After correction the limb from toes to upper thigh should be well padded, especially around the knee, when considerable swelling may take place, by cotton batting or sheet wadding, and a plaster-of-Paris bandage applied, the limb being held in the corrected position until the plaster has set.

5. **Supracondyloid Osteotomy.** When the deformity present cannot be corrected by mechanical means linear osteotomy just above the condyle may be performed. While this procedure retains in the joint any motion that may be present, it does not correct the faulty angle formed by the articulating surface.

6. **Excision.** This is performed in cases when ankylosis is complete. The technic of this operation will be described below.

Authorities differ in regard to the relative value of these last two operative procedures. Poinset believes resection preferable, for the reason that the removal of all diseased tissue obviates the possibility of subsequent inflammation, and has recorded seventy-seven collected cases, with a mortality of 8 per cent. He regards the operation as entirely free from danger in patients under fifteen years of age. Jacobson, on the other hand, thinks excision should be abandoned for the better operation of osteotomy, strongly urging caution in rapidly and completely straightening a knee-joint which has long been the seat of a bony ankylosis in a bad position, the dangers being pressure upon the popliteal vein and tetanus from stretching of the contracted popliteal fascia and

the popliteal nerves. The best methods would appear to be forcible manual extension, forcible mechanical extension, osteotomy, and resection, in the order named. Resection should be reserved for bony ankylosis in adults, and should be abandoned for osteotomy in all cases when possible. The operative procedure, surgical technic, etc., will be found described in works upon general surgery.

When operative measures are declined, an apparatus to overcome the shortening will assist the patient in walking.

Abscess.—Under efficient mechanical treatment suppuration and fistulas are less frequent, but when abscesses occur they may be treated on the same general plan as hip abscesses. Small localized abscesses may be allowed to remain with the hope of reabsorption, or to open spontaneously while the limb is firmly fixed in some retaining apparatus, after the method recommended by Volkmann and Billroth. Large burrowing abscesses should be freely opened under full antiseptic precautions, but small circumscribed ones may be allowed to burst spontaneously. If the accumulation of fluid be great, it should be removed by aspiration under the most rigid antiseptic precautions. The general management of abscesses will be the same as described under abscess in hip disease. Even after numerous abscesses have formed and discharged, spontaneous recovery may follow. Abscess formation occurs in about one-third of all cases. It usually results in those cases in which treatment has been delayed or faulty. Its frequency is shown by the statistics of Gibney, 47 per cent.; and König, 51 per cent.

Expectancy.—As long as the general condition of the patient remains good, an attempt may be made to secure recovery by rest and fixation and the

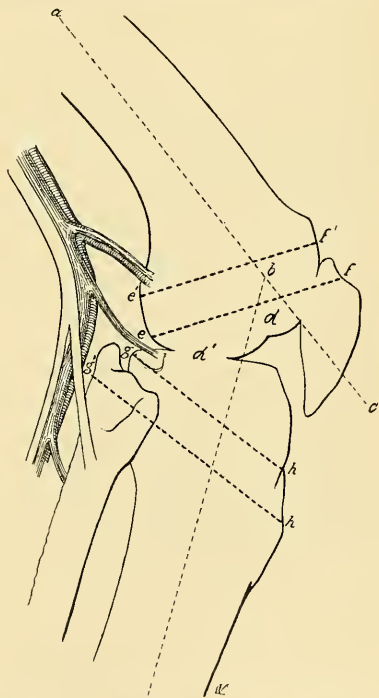


FIG. 357.—ORTHOPEDIC RESECTIONS FOR ANKYLOSIS FOLLOWING KNEE-JOINT DISEASE.

use of antiseptic injections. The sinuses should be irrigated daily with a 1 : 2000 bichlorid solution, to be followed, if the sinus be free, with injections of pure peroxid of hydrogen, washed again with the bichlorid solution, and injected finally with from 1 to 4 drams of emulsion of iodoform in sterilized sweet oil in the strength of 10 per cent., after which a full antiseptic dressing should be applied, and the limb secured in a plaster-of-Paris cast or other apparatus. Under this plan of treatment the discharge may lessen, the sinuses close, and ultimate recovery quickly ensue. Some of the injections formerly used may still be prescribed with benefit, as solutions of nitrate of lead, potassium permanganate, or dilute carbolic acid (2 to 5 per cent.).

The disintegration and discharge of necrotic tissue may be hastened by the use of solutions of nitric acid (3 per cent.), with or without the addition of active solutions of pepsin. After these preparations have been allowed to remain in the sinuses for twenty or thirty minutes, the cavities must be irrigated with bichlorid solution to remove the digested tissue.

Operative Treatment.—In cases that become progressively worse after conservative measures have been tried unsuccessfully; in those that have, from the beginning, been very extensive; in those in which there are large abscess cavities connecting with the joint, showing mixed infection, and which are not draining properly, and in those in which the general health is failing rapidly, operative measures are to be resorted to. These may be considered under the three following heads: (1) Arthrectomy; (2) resection; (3) amputation.

1. **Arthrectomy**, or erosion, consists in laying open the joint and by means of the bone curet removing all of the diseased tissue, irrigating the joint freely with bichlorid solution during the operation, passing drainage-tubes through the joint, dressing the wound antiseptically, and immobilizing the joint. As a substitute for excision, this operation has been employed by many surgeons, both at home and abroad, and offers advantages over the latter operation in children and where the disease is not extensive, where thorough removal can be accomplished, and especially where the synovial membrane alone is affected. Its chief advantages are that it does not usually prevent the after-growth of the limb and does not cause complete ankylosis. The operation, in brief, is as follows: Hemorrhage is controlled by an Esmarch bandage and tourniquet above the knee; the joint is exposed by a transverse curved incision with its convexity downward. The incision may be made above, below, or through the patella. The synovial membrane should be dissected out and all foci in bone should be carefully removed by means of gouge and chisel. All infected

material should be removed, and the joint thoroughly irrigated with corrosive solution. Often it will be found of value to use the Paquelin cautery in the walls of cavities which remain after the use of the chisel and curet. The operation should be done under strict aseptic precautions, and in a few cases we may expect primary union to take place. The majority of cases, however, require drainage. The limb should be immobilized in a plaster-of-Paris splint.

Statistics on Arthrectomy.—König's statistics on the result obtained in 150 cases on whom arthrectomies were performed are as follows: 3 died as a result of the operation; the final results in 133 showed that 94 entirely recovered of the local disease, 27 showed that there was still evidence of local disease, and 23 were dead. Of the 94 cases that entirely recovered from the local disease, 10 had fair motion; the others had ankylosis. Shortening was absent in 27, slight in 40, moderate in 20, and marked in 7 instances.

2. Resection or Excision.—This is essentially an operation to be performed only in adult life when we wish to obtain bony ankylosis and wish to avoid the long tedious disability incident to conservative treatment. It is practically never performed during childhood, on account of the great shortening which results from removal of the epiphyses. Resection does not ultimately yield as good results as does conservative treatment, the mortality rate is higher, the functional results are not as good, and in some cases there results considerable flexion. The operation is performed as follows: Hemorrhage may be controlled by a tourniquet above the knee; the joint is opened by an incision similar to that described above for arthrectomy. The joint is opened and all diseased structures are carefully cut away. Sections of the femur and tibia are removed parallel with the articular surfaces, until all the diseased bone has been removed. The joint is irrigated with salt solution; the periosteum is stitched together with heavy catgut. The wound may be closed with or without drainage. A



FIG. 358.—EXCISION OF KNEE-JOINT.

sterile dressing is applied and the limb placed in a plaster-of-Paris splint reaching from the toes to the upper thigh. While the bandage is being applied care should be exercised to avoid any posterior displacement of the upper end of the femur, and hyperextension should also be avoided. Windows may later be cut in the lateral aspects of the bandage at the knee to facilitate dressing the wound. Instead of plaster-of-Paris a posterior splint may be used. A good plan is to place the limb in the corrected position on a Cabot posterior wire splint, and over this apply a plaster-of-Paris bandage. Care should be taken not to allow the patient to bear weight on the leg for a number of months following operation. A suitable ambulatory apparatus may be applied so that the patient bears all the weight on a perineal crutch.

Statistics on resection. König's statistics on the result obtained in 300 cases in whom resection was performed are as follows: A good result was obtained in 222, there were 6 deaths due to the operation, and 23 occurred later during the course of treatment after operation. In 23 instances it was necessary to perform secondary amputations. Of the 222 in which a good result was obtained, their condition on discharge was: 188 cured, 31 cured at some later date, and in 3 there persisted slight fistulas. In 175 cases the leg was straighter and in 18 cases there was deformity. The mortality in all cases was 9.6 per cent.

Phelps' statistics, based on a study of 329 cases, give a mortality of 31 cases, or 9.4 per cent.

Lossen's statistics, based on an analysis of 586 cases in which resection was performed, are: 439 entirely healed, 59 not healed, 50 required secondary amputation, and 38 (6.5 per cent.) died as a result of the operation or during the course of the after-treatment. This mortality was afterward raised to 9.4 per cent., based on an observation of 384 cases seen at the end of fourteen years.

The mortality rate as shown by the above statistics—König, 9.6 per cent., Phelps, 9.4 per cent., and Lossen, 9.4 per cent.—is about the same.

3. **Amputation.**—Amputation is to be resorted to only when the general health of the patient is gradually failing and the disease is extensive and steadily progressing. According to Agnew, "excision is always to be preferred for children, and amputation for adults," and this agrees, in the main, with the opinion of most surgeons of large experience, the question being largely one of individual judgment. In children, in rare cases, where the resection must remove a very large portion of the shafts of both bones, amputation may be considered. In adults excisions, under strict antiseptic precautions, yield

better results than formerly, and may be resorted to when they offer a prospect of cure, amputation being reserved as a life-saving measure. In many cases a positive decision cannot be formed until the joint has been freely exposed. The point of amputation will depend upon the judgment of the operator, but in general terms it can be stated that the site should be sufficiently high to remove diseased bone and tissue, and should give a stump that will heal quickly and be of service. For the operation of amputation readers are referred to works on general surgery.

Mortality. König's statistics, based upon 690 cases of tuberculous knee-joint disease treated in the Göttingen clinic, show that 201 cases died. Of these 201 cases, death followed operations in 18 instances, resulted from causes not connected with tuberculosis in 14 instances, and in 141 instances was due to tuberculosis. This shows a mortality rate of 22.5 per cent. of all cases treated. The distribution of the lesions causing death in these 141 cases was as follows: Tuberculosis of the knee, 1; acute miliary tuberculosis, 3; tuberculous meningitis, 7; general tuberculosis, 30; tuberculosis of the lungs, 94; and tuberculosis in other parts, 6.

These statistics are much higher than those of Gibney, based upon 300 cases. The causes of death in the 40 cases observed by Gibney were as follows: Shock due to the operation, 1; prolonged suppuration, 16; tuberculous meningitis, 6; tuberculosis of the lungs, 3; and 14 from intercurrent diseases. Of these, only 26 were directly due to tuberculosis, so that a mortality rate of 8.6 per cent., as compared with that given by König (22.5 per cent.) shows a marked difference.

Résumé.—Tuberculous knee-joint disease on account of the accessible nature of the parts involved yields very readily to treatment. The patient's general condition should be carefully investigated and improved as much as possible. Most cases can be treated by ambulatory apparatus. Conservative methods yield most excellent results. The mortality in children should not exceed 10 per cent., and over 50 per cent. of cases should recover with good functional results. In cases of suppuration of the joint with continued high fever the conservative treatment should not be prolonged, but operative measures used. General weakness, presence of multiple foci, especially advanced phthisis or severe amyloid degeneration, old age, and rapid disorganization of the joint are indications for amputation.

CHAPTER VII.

NON-TUBERCULOUS KNEE-JOINT DISEASE.

Acute Serous Synovitis.

Etiology.—Acute serous synovitis of the knee-joint may be caused by direct or indirect traumatism, or may be the result of local or general diseases. Following some local traumatism, there may occur slight swelling about the knee, accompanied by slight pain, limp, and moderate flexion. Acute synovitis as a result of indirect traumatism is seen in cases in which some sudden movement of the body gives a sharp twist at the knee-joint; it may also follow turning over suddenly in bed, so that forcible rotation is made at the knee; may follow “catching the toes” over some unseen obstacle, as the edge of the carpet, curb-stone, etc. It is seen very commonly in football players and men engaged in track athletics, baseball, hockey, etc. It may be a local manifestation of some general disease, as rheumatism, scarlet fever, smallpox, typhoid fever; or may be due to a local inflammatory condition near the joint, as a septic prepatellar bursitis, septic abrasions, and furuncles near the knee-joint. Occasionally it is found as a symptom of urethral fever.

Pathology.—The effusion following mild traumatism varies in amount, is yellowish, clear, contains albumen and a few red and white blood-corpuscles. If the injury has been severe, there is usually moderate hemorrhage, so that the fluid is yellowish-red; there is also a certain amount of fibrin, which in time is deposited on the entire synovial membrane. The synovial membrane is usually edematous and throughout presents small areas of ecchymosis. If the effusion is rapidly absorbed, the joint usually returns to its normal appearance; but if the condition becomes chronic, the fibrin becomes organized, all intra-articular and peri-articular structures gradually becomes thickened and softened, but if resolution occurs all the tissues return to their normal condition without injury.

Symptoms.—The most characteristic symptom of acute synovitis is the *swelling* which takes place as a result of the increased amount of fluid in the knee-joint. The para-patellar grooves are obliterated and in their place are found distinct bulgings which may in extreme cases extend upward and merge above the patella. Usually the swelling is continued upward above the patella

for a distance of three to four inches, corresponding with the subcrureous bursa; and at times a swelling may be found in the popliteal space due to the connection, which occasionally occurs, of the bursæ of the semi-membranosus and popliteal bursæ. *Fluctuation* is of varying degrees, and is found best by having the leg in full extension and by the examiner standing on the outside of the knee, obliterating the subcrureous bursæ with the palm of the right hand when examining the left knee, and vice versa, the thumb of the right hand being placed along the outside of the patella, and excess of fluid can be noticed by gently tapping on the inner side of the knee close to the patella by the fluid wave which is conveyed to the thumb of the right hand. The amount of effusion can be determined by the extent to which the *patella is floated*. The leg should be in full extension, otherwise small amounts of effusion will be overlooked. There may be slight *increase of local temperature*. The knee is slightly flexed. Pain is practically absent, except in extreme flexion.

Diagnosis.—This rests upon the acute local signs, history of injury, and absence of subjective symptoms. It is to be distinguished from tuberculous ostitis and hysteric joint.

Treatment.—The entire limb should be immobilized in a plaster-of-Paris splint, celluloid splint, posterior tin or wood splint for several days until the swelling has disappeared. Locally flying blisters and tincture of iodine do good in the beginning. This immobilization may be combined with pressure by means of adhesive plaster, rubber elastic bandages, compressed sponges, or repeated graduated pressure. After the acute symptoms have subsided massage and hot air are of much benefit in promoting the absorption of the effusion. During the active stage and until convalescence is well established the patient should use crutches, and should afterward avoid sudden jars or twists which might reproduce the same condition in a joint favorably disposed.

Chronic Serous Synovitis.

Etiology.—Chronic serous synovitis is usually preceded by acute serous synovitis. In many cases of acute synovitis the acute symptoms gradually subside, leaving a knee-joint which usually contains a slight amount of fluid and causes considerable disability; very often the acute form may be due to some internal derangement following injury, and on the least provocation all symptoms, but to a less degree, occur that were present in the acute attack. Among the causes to be ascribed to this condition may be mentioned fringes, loose bodies, lax ligaments, partial dislocations of the patella, and loose semi-

lunar cartilages. The condition may occasionally be chronic from the beginning, in which case it is usually due to some general disease or malnutrition.

Pathology.—If the condition present in acute serous synovitis continues, organization of fibrin takes place within the joint, the synovial membrane remains thickened, considerable peri-articular edema takes place, exfoliation of the cartilage occurs, exuberant granulation tissue forms from the edges of the cartilages project into the joint cavity as synovial fringes, become free, forming loose bodies, and finally there occurs a relaxed condition of the articular structures with lateral mobility, so that the muscles finally fail to control the joint.

Symptoms.—The subjective symptoms are those that can be attributed to the relaxed condition of the joint. The history is usually one of repeated attacks of acute serous synovitis resulting from traumatism. Pain when present is usually diffused about the joint, there may be some hyperesthesia of the skin. The patient complains of a feeling of weakness in the joints, inability to lift heavy weights, and at times is unable to support the weight of the body on the joint for any considerable period. Objectively swelling occurs early, obliterating the parapatellar grooves, and causes floating up of the patella. The mobility of the joint is not interfered with except in cases due to loose cartilages and bodies in the joint; in fact, in most cases lateral motion is possible to a greater or less extent. In some cases distinct crepitation can be felt, which may vary from a leathery crepitation to one of a rough, grating character. This is due to plastic deposits on the synovial membrane, fringes catching between the articular surface, and para-articular areas of induration.

Diagnosis.—Chronic serous synovitis is diagnosed by the history, the duration of the disease, the presence of fluctuations, floating up of the patella, absence of muscular spasm, limitation of motion, fever, and signs of local inflammation, involvement being confined to the synovial membrane, lax condition of the periarticular structures, and occasionally by the presence of distinct crepitation within the joint.

It is to be distinguished from tuberculous joint disease by the history, absence of periarticular induration, fever, muscular spasm, and flexion. From prepatellar bursitis it is distinguished by the history, by the swelling being confined to the prepatellar region, and absence of fluid in the joint and floating up of the patella in the latter condition.

Treatment.—Chronic serous synovitis does not yield readily to treatment. This consists of moderate fixation, protection, compression, and in the later stages of massage, hot air, and supports.

Fixation may be by means of plaster-of-Paris or a posterior tin or wood splint. This should be continued until the more active symptoms have somewhat subsided, when moderate motion should be allowed if the joint is well protected. Compression can be obtained by adhesive plaster applied diagonally around the knee, from six to eight inches below to the same distance above, and a space should be allowed posteriorly so as not to retard the circulation. Dry sponges may be applied around the knee by means of a bandage, and when wet will expand causing compression. The entire leg and thigh may be surrounded by sheet wadding, and outside this a layer of binder's board which has been made pliable by hot water, and around the entire dressing a firm bandage applied. Instead of the binder's board a bandage may be applied around the sheet wadding and reinforced daily. Elastic bandages and elastic knee stockings may be used to cause compression.

During the entire course of chronic serous synovitis the use of massage and hot air has been attended by very beneficial results. It promotes the circulation about the joint, thereby increasing the absorption of the effusion, and at the same time it helps to tone up the lax condition of the muscles and ligaments.

The advisability of incision and irrigation in obstinate cases of chronic synovitis is at present debatable. While some incline to this radical procedure, others hold to the more conservative measures. The fluid in the joint may be removed by aspiration and the entire synovial sac filled with carbolic acid solution (3 per cent.) which is removed and renewed until the fluid returns clear. All fluid is then expressed and a compression bandage and posterior splint or plaster-of-Paris splint applied for a week or ten days. If at the end of this time the fluid is not entirely absorbed, the procedure may be repeated several times. Tincture of iodine and a 10 per cent. iodoform-oil emulsion are other solutions that have been employed instead of the carbolic acid solution. Some operators prefer to incise the joint, irrigate thoroughly with carbolic acid solution (3 per cent.) or corrosive sublimate solution (1 : 5000), normal salt solution or sterile water, and after expressing the excess of fluid to close the wound and apply a compression and fixation dressing. Opening of the knee-joint has always been attended with considerable risk to the patient, and the author does not feel warranted from a study of the cases seen and reported to advise this radical procedure, as long as the contents of the joint remain serous. Patients who are subject to this condition should always wear an elastic bandage, stocking, or some support to protect the knee-joint from sudden twists and jars.

Acute Suppurative Arthritis—Phlegmon.

Etiology.—Acute suppurative arthritis of the knee may occur after incised and gunshot wounds entering the joint, localized infections near the joint, may be due to the infectious diseases, may follow operations upon the joint, and in children may be primary within the joint or secondary to an acute epiphysitis.

Pathology.—As a result of infection the synovial membrane becomes hyperemic, stasis of the blood-current occurs, the capillaries dilate, followed by an outwandering of leukocytes and hypersecretion of synovial fluid. The infiltrated walls of the synovial membrane become red, edematous, and lusterless; the peri-articular structures gradually become infiltrated, swollen, and adherent to surrounding structures. The contour of the joint rapidly changes, the synovial sac becomes very tense, its layers become disorganized and necrotic, and finally ruptures into the surrounding structures, with the formation of abscesses running up the thigh and down the leg, guided by the intramuscular septa, fistulas and entire destruction of the joint. The severity of the infection depends upon the cause, and the results obtained depend upon the promptness of operative interference.

Symptoms.—As a result of one of the causes cited above, there may occur slight swelling of the knee-joint, accompanied by increased synovial fluid, absence of fever for a few days, very little pain, some local tenderness, gradually however, the temperature begins to rise rapidly, giving the first suspicion of suppuration taking place within the joint. The fever continues high, ranging between 103° and 105° , accompanied by rapid pulse-rate, sweats, and chills; pain becomes marked, especially on motion, flexion occurs; instead of the normal color and appearance of the skin, the latter becomes tense, red, edematous and glossy; the local temperature is increased; the leg and foot become enlarged, tender, and pits on pressure, due to obstruction of the venous return from pressure; lymphangitis occurs, the femoral glands become enlarged, tender, and may fluctuate; fluctuations and floating up of the patella occur. The constitutional signs are very marked; there are distressing headache, loss of appetite, vomiting, and in severe cases delirium and coma.

Treatment.—In no joint disease are operative measures more urgently called for than in acute suppurative knee-joint disease. If the condition is suspected, the joint should be aspirated under most aseptic precautions. If the fluid obtained is turbid, flocculent, or purulent, and microscopic examination of the fluid shows the presence of micro-organisms, the joint should be thoroughly incised, irrigated and drained. The joint may be opened by two long curved

incisions on either side of the patella, the joint cavity thoroughly exposed, irrigated with salt solution, drained freely, a moist antiseptic dressing applied, and the limb placed on a posterior wire splint. The knee-joint may also be widely opened by a transverse incision carried above, below, or through the patella. At times it may be found necessary to have dependent drainage through the popliteal space. Whatever incisions may be used, drainage should be thorough and free. In many cases abscesses will form along the intermuscular septa below and above the knee, which will require multiple incisions and drainage. In gunshot injuries and when the articular surfaces are destroyed, resection may be necessary. In most cases complete ankylosis occurs. If the infection is very severe, as shown by the local condition and evidence of septic absorption, amputation may be necessary to save life and should never be delayed.

The deformity following acute suppurative arthritis is usually moderate flexion combined with outward rotation and abduction of the leg. Throughout the treatment efforts should be made to prevent this deformity by means of suitable splints.

The after-treatment consists in massage, hot air, electricity, active and passive exercises. If deformity is present, attempts should be made to correct it according to the degree of ankylosis present, as described in the chapter on ankylosis.

Prepatellar Bursitis.

Of the bursæ not communicating with the knee-joint, the one most frequently the seat of disease is the prepatellar bursa. This is accounted for by its exposed position and by the fact that in kneeling considerable weight is thrown upon the lower edge of the patella and patellar ligament. The prepatellar bursa lies between the skin and the patella and upper half of the patellar ligament. It is not always well defined, and usually consists of three portions,—the subcutaneous, subaponeurotic, and subtendinous,—all usually communicating with each other.

These bursæ may be subject to acute, chronic, and suppurative inflammation.

Acute Prepatellar Bursitis.—This usually follows as a direct result of traumatism, but may be due to a localized inflammatory condition of the skin near the bursæ, or to overuse.

Symptoms and Diagnosis. Following trauma or a localized sepsis of

the skin there occur swelling and fluctuation confined to the prepatellar region, which is made more tense by flexion, some pain on flexion, and tenderness on pressure. It is differentiated from synovitis by the localization of the swelling to the prepatellar region, by absence of fluid in the joint, and floating up of the patella.

Treatment. This consists in placing the joint at rest by the application of a posterior splint and use of crutches. In addition, counterirritants may be used, as tincture of iodine, cantharides, etc. The fluid may be removed by aspiration and compression applied. In the acute cases compression by means of elastic bandages, wet sponges, etc., is very beneficial. If the condition is due to a localized area of inflammation, appropriate treatment for the latter will soon be followed by favorable results. •

Chronic Prepatellar Bursitis.—This condition may, though it rarely does, follow an acute attack. It is usually seen among those who are compelled in their work to spend considerable time on their knees. This is especially so among those whose work requires leaning forward laterally and backward on their knees, as in the occupation of scrubbing floors. These motions, especially that of leaning forward, bring considerable pressure over the prepatellar region, which in time produces marked thickening of the walls of the bursæ and the exudation of fluid into the bursæ. This gradually leads to the formation of a tumor varying in size, and at first limited to the prepatellar region. As the condition becomes chronic, there are formed within the bursæ thick fibrous bands which usually run from the walls of the bursæ and may project free into the cavity or be attached to the opposite wall.

Synonym. "Housemaid's knee."

Symptoms. Excepting some limitation of flexion, the subjective symptoms are very slight. The patient is unable to state definitely when the swelling was first noticed. This is fairly firm, semi-fluctuating, of rather doughy consistency, limited to the prepatellar region, made tense on flexion, and the overlying skin is of a brawny character.

Diagnosis. It is differentiated from synovitis by the occupation of the patient, by its limitation to the prepatellar region, by its tenseness on flexion of the knee, by the absence of fluctuation in the knee, and by the fact that the patella does not float.

Treatment. In the mild form of chronic bursitis the fluid may be aspirated and the bursæ filled with a 3 to 5 per cent. carbolic acid solution, washing the latter out with sterile water and then applying a posterior splint and compression.

If this fails, and in the author's experience it usually does, the bursæ may be dissected out through a transverse, vertical, or curved incision, using throughout the most thorough aseptic precautions. The wound may be closed, a sterile dressing and posterior splint applied, with the expectation of allowing the patient to resume work in four to five weeks; or the bursæ may be opened, the walls cureted and allowed to heal by granulation. In the very severe forms the only possible means by which a cure can be obtained is by thorough dissection of the sac from the surrounding structures.

Suppurative Prepatellar Bursitis.—This condition may be the result of an acute or a chronic bursitis, especially the acute form due to a localized septic process as a furuncle or a lacerated septic wound.

Symptoms. Suppuration of the bursa is shown by heat and redness of the skin, by swelling, at first limited to the prepatellar region, but later it may extend in all directions and simulate a suppurative arthritis. There is usually a septic wound near to or entering into the bursæ. Fever, moderate pain or flexion, lymphangitis, enlargement of the femoral lymphatic glands, are usually present in this condition.

It is differentiated from suppurative arthritis by the absence of fluid in the joint, by the fact that the patella does not float upward, and by the limitation to the prepatellar region.

Treatment. This consists in free incision, cureting thoroughly, or at times excising the sac, and allowing the wound to close by granulation.

Pretibial Bursitis.

The pretibial bursæ are two in number—the superficial and the deep. The superficial pretibial bursa is situated between the skin and the tibial tubercle, at the insertion of the patellar ligament.

The deep pretibial bursa lies between the patellar tendon and the periosteum of the tibia. It is triangular in shape, and extends from the tibial tubercle upward as far as the joint. The superficial bursa may communicate with the prepatellar bursa, but the latter never communicates with this bursa or with the knee-joint. Inflammation of these bursæ are usually due to injury.

Symptoms.—Inflammation of the superficial pretibial bursa is recognized by the appearance of a swelling over the tibial tubercle, and may simulate hypertrophy of the tubercle; there is usually localized pain and tenderness on pressure. Tension in the bursa is not influenced by movements at the knee-joint.

Inflammation of the deep pretibial bursa is recognized by the appearance on either side of the patellar ligament of a fluctuating swelling obliterating the normal parapatellar grooves. There is usually considerable interference with motion, which is accompanied by pain. The condition resembles an effusion in the knee-joint on account of the position of the swelling, but while fluctuation is present there is never any floating up of the patella. This bursa may be the subject of acute, chronic, or suppurative inflammation.

Treatment.—The effusion in the superficial form will usually disappear by strapping with adhesive plaster or some form of compression. In the deep variety the effusion will usually disappear with immobilization, compression, moist heat in the form of compresses or by hot air. If this is ineffective, the sac may be aspirated and washed out with carbolic acid (3 to 4 per cent. solution) and then immobilization and compression applied. This will in most cases be followed by favorable results. In the suppurative variety the bursa should be incised, drained, and allowed to heal by granulation. If operative interference is sufficiently prompt, infection of the knee-joint may be avoided.

Enlargement and Fracture of the Tibial Tubercle.

Enlargement of the tibial tubercle is usually due to a localized osteitis or periosteitis following injury or bursitis of the superficial pretibial bursa. It consists of thickening of the tubercle, which is slightly tender on pressure, and is shown externally by moderate swelling. At times there may be indistinct fluctuation or elasticity over a hard base. The condition usually improves with the local application of tincture of iodine or some other counter-irritant.

Separation of the tibial tubercle is usually due to muscular action. It rarely occurs from direct violence, and is more common during adolescence. Examination shows the presence of a small irregular bony mass about the size of a walnut, which is drawn upward with the patellar ligament by the action of the quadriceps extensor muscles; this is accompanied by tenderness on pressure, by effusion into the knee-joint, and by inability to extend the leg fully. Treatment consists in immobilization on a posterior splint and traction by means of adhesive plaster placed above the separated tubercle. This will usually bring the tubercle nearly to its normal position and will give a useful joint. If it is impossible to draw the tubercle down to its normal position, it may be cut down upon under the most careful aseptic precautions and the

torn periosteum sutured. The wound should be closed, covered by a sterile dressing, and a plaster-of-Paris bandage applied from the toes to the upper thigh. At the end of one month the patient may be allowed on crutches, and to use the leg at the end of two months.

Popliteal Bursæ and Cysts.

Cysts found in the popliteal space usually have their origin in bursæ formed by protrusions of the synovial membrane of the knee-joint. These cysts may continue to be connected with the joint or after a time there may be nothing to suggest their connection with the joint. The view has been expressed by Riese (*"Centralblatt für Chirurgie,"* 1898, p. 585) that these swellings have no connection with the joint, but are true cystic tumors of degenerated fibrous tissue. He found that in the blood-vessels supplying these tumors there existed an obliterating endarteritis.

These cysts are found in early adult life. They vary in size from a small walnut to irregularly shaped tumors that may extend from the mid-thigh to the mid-leg. As a rule, they attain the size of a pigeon's egg. They may be situated along the inside of the semi-membranosus tendon, they may form between the origin of the two heads of the gastrocnemius muscle, or may lie just inside the tendon of the biceps.

Symptoms.—They are usually recognized on extension of the leg, and cause a feeling of tension, or at times extreme pain on walking. At times they become so large as to cause pressure on the veins in the popliteal space. If they communicate with the knee-joint, pressure upon them will decrease their size and cause an increased amount of fluid in the knee-joints.

Diagnosis.—They are to be differentiated from lipoma, sarcoma, tubercular abscesses, and aneurysm. The diagnosis rests upon the presence of a painless, smooth, fluctuating swelling in the popliteal space which may be decreased by pressure, and this is accompanied by effusion into the knee-joint and through the two sacs distinct fluctuation can be felt.

Treatment.—On account of the proximity of the popliteal vessels compression cannot be used. In those which do not communicate with the joint, the fluid may be aspirated and the sac irrigated with carbolic acid (3 per cent.) or tincture of iodine. If, however, they communicate with the joint, the only treatment that will be followed by favorable results is thorough dissection of the sac from surrounding structures under aseptic precautions.

Loose Bodies in the Knee-joint—Joint Mice.

Loose bodies in the joints other than the knee are rarely seen. This is probably due to the fact that the anatomy and position of this joint render it particularly liable to injury. About 90 per cent. of loose bodies are found in the knee-joint.

Etiology.—At one time it was thought that free bodies resulted from injury to the knee-joint. In many cases this was so slight, and in some no history of injury could be obtained, so that it is doubtful if trauma alone can be the etiologic factor. Claims have been made that by twists or by direct injury portions of the articular cartilage were torn off; experiments, however, have been made to show that great violence is necessary to separate fragments from the articular surface. König, among others, holds to the view that they are formed by a process of osteochondritis following trauma, and that they are gradually separated from the bone in this way. Bradford holds that, following injury, these pieces are so injured and bruised that necrosis takes place, and as a result an osteochondritis which finally leads to their separation. Barth considers that those cases in which the lesion is situated on the internal condyle near the intercondyloid fossa follow tearing of the crucial ligaments caused by sudden rotation of the leg. As a pathologic condition free bodies are seen in arthritis deformans.

Constituents of Loose Bodies.—The free bodies found in arthritis deformans consist of detached portions of bone and cartilage and villi consisting of cartilage and bone which have been detached from the synovial membrane and are known as synovial fringes. Those found in otherwise normal joints consist of cartilage; cartilage and bone, either of which may form as a nucleus and be surrounded by the other; fibrin surrounded by cartilage, the fibrin being the remains of an old effusion, and encapsulated foreign bodies.

These loose bodies vary in size, number, and shape. They may be in size anywhere from that of a millet-seed to that of a walnut. In number they have been found singly, three to four at a time, and one case is reported in which about four hundred were removed from the knee-joint. In shape they have been found to vary. When a number are present, they may be shaped like melon-seeds or may be pyriform. Or if only a few are present, they are usually faceted and may be concavo-convex. These bodies may be free or be attached by a pedicle.

Symptoms.—In most cases the first symptom that the patient notices

is while engaging in some rather violent exercise in which the knee is given a sudden twist, or simply while walking or stooping, there is sudden agonizing pain in the joint, which in some instances is so great as to render the patient sick and faint; he is unable to straighten his knee, and falls to the ground in great pain. This is followed by an acute synovitis which gradually subsides, leaving a joint in which there is moderate effusion and which the patient feels is somewhat weakened. Before this acute attack, however, there may have been some slight trauma which the patient failed to notice, but which he will remark if his attention is called to it, that there was for an indefinite time preceding the acute attack, slight grating on extension and an occasional swelling of the joint, which, however, did not in any way interfere with its function. There may be a repetition of these acute attacks, occurring at irregular periods; at times the patient suddenly twists the knee while it is slightly flexed, or while walking is unable to extend the knee, or sometimes the reverse; there is the feeling as though something is caught. After a time the motions of the joint are unrestricted, but there follows an effusion into the joint. These attacks may occur so frequently as to render the joint entirely untrustworthy, and the joint cavity continually distended with fluid, but with the lessening of the intervals between the attacks the joint reacts less to injury and the synovitis is not so severe.

Very often these loose bodies may be felt through the soft parts about the joint. They are usually detected over the condyles of the femur to either side of the patella, or at times may be felt over the tibia near the patellar ligament. At times it is impossible to find them, and when found they readily escape.

Diagnosis.—This rests upon the history and the detection of the loose body. At times we must depend upon the statement of the patient that he can feel the body, and after repeated examination we may be fortunate enough to be able to detect it. To differentiate the presence of loose bodies from dislocation of the semilunar cartilage is at times very difficult. In the latter condition the catch in the joint is always from flexion to extension, and in the former the reverse is often the case; in the latter there is usually a very tender point over the inner head of the tibia, and to produce extension from a flexed position, pressure at this point, with outward rotation of the leg, is usually necessary.

Treatment.—If the loose bodies are the result of arthritis deformans, it is often not advisable to remove them, as the joint may be so far destroyed

that little good would result. In the other class of cases the only method of treatment that will be of use is operative interference. Most thorough asepsis should be employed. If possible to detect the body, it may be held in place by a needle transfixing it, and then the needle used as a guide. If this is not feasible, the joint should be opened and thorough search made and all bodies removed. Irrigation of the joint is not advisable. The wound should be closed without drainage by layer sutures, and a sterile dressing and posterior splint then applied.

Dislocation of the Semilunar Cartilages.

Synonym.—Hey's internal derangement.

Etiology.—The majority of cases are due to traumatism indirectly applied. The resulting lesion is a forcible tearing of one or rarely both semilunar cartilages, from the anterior or posterior aspect of the spine of the tibia or from along its peripheral attachment to the capsule or cartilaginous surface of the tibia. In some cases the cartilage may be torn in one or several places in a radiating direction. It may be entirely detached and forced into the joint or may not be displaced at all. The internal semilunar cartilage is most frequently affected. This is accounted for by the fact that the motion which is necessary to cause its separation is outward rotation of the tibia, which motion takes place toward the end of flexion, and when this motion is very forcible the internal semilunar cartilage is very liable to be torn from its attachments, or forcibly compressed between the two articular surfaces, so that separation from its attachments or a radiating fracture occurs. Whether the less range of motion enjoyed by the internal cartilage has anything to do with the frequency of its involvement cannot be definitely stated. The accident usually occurs during moderate flexion in young adults while engaged in outdoor exercises.

Symptoms.—While engaged in some exercise the patient twists the knee suddenly and experiences sharp pain in the knee; this may be so severe as to cause faintness or may be slight; it is followed by the impairment of movement at the joint, by the occurrence of an acute synovitis, in most cases the effusion containing blood, and local tenderness over the seat of the torn semilunar cartilage. If the injury occurs by outward rotation of the leg, or if the leg is fixed by inward rotation of the body at the knee, the inner semilunar cartilage is injured and vice versa; in all cases the knee is considerably flexed when the injury occurs.

The immediate results of the injury disappear under appropriate treatment

when there is no displacement of the cartilage, when, however, this occurs the patient finds that he is unable to extend the leg on account of locking of the joint, and it is often necessary to reduce the cartilage under anesthesia.

Following the acute attack the patient finds that the joint is weakened, that he is unable to place the knee in certain degrees of flexion with rotation of the leg without the displacement recurring, so that he becomes careful to avoid these movements.

The cartilage after injury may not be displaced, and with appropriate treatment the torn edges may unite; in the greater number of cases the cartilage is displaced and acts as a wedge in the joint, preventing full extension of the leg. In this class of cases an anesthetic is sometimes necessary for reduction. Very often the displaced cartilage may be felt beneath the skin. After repeated attacks the process of reduction becomes familiar to the patient. This consists in full flexion, then inward rotation of the leg if the external semilunar cartilage is involved, and outward rotation if the internal cartilage is displaced; while this is being done, efforts should be made to separate the joint surfaces as far as possible, and while pressure is exerted over the position of the displaced cartilage the leg should be quickly but not forcibly extended. After repeated attacks a chronic effusion results, there is moderate impairment of function at slight lateral motion, and some laxity of the entire joint structures.

Treatment.—In the acute cases in which no displacement of the cartilage has occurred attempts should be made to obtain union by immobilization for four to six weeks, and at the same time massage of the calf and thigh muscles should be given. At the end of this time the patient may be allowed to use the limb, which, however, should be supported by an elastic knee-cap. In some cases it is well to place some firm material in the posterior portion of the knee-cap to prevent full flexion.

If the cartilage is displaced and thereby prevents free motion in the joint, it may be reduced by the method given above, after which the limb should be immobilized and at the end of six weeks the patient may be allowed to walk with Marsh apparatus or other appropriate support, and always bearing in mind to avoid those movements which will cause a recurrence of the dislocation.

If the dislocation is impossible to reduce, or has existed for a long time, or if the attacks become so frequent as to render the function of the joint much impaired, operative treatment is advisable. This consists in open-

ing the joint under aseptic precautions by a transverse or vertical incision to either side of the patella. If the cartilage is only separated from its peripheral attachment to the tibia, or if there exists only a radiating tear, so that very little displacement occurs, it may be sutured in place with catgut. If a separation exists between the cartilage and the tibia, or a portion of cartilage projects into the joint, or if any of the portion involved looks diseased, then the involved portion should be removed. If necessary, the entire cartilage may be removed. After thorough exploration of the joint the wound should be sutured, a sterile dressing applied, and the joint immobilized for six to eight weeks. During this time massage should be used to keep up the tone of the muscles, and at the end of this time the patient may be slowly allowed to take passive motion. After a time use of the limb should be encouraged.

Results of Partial or Total Excision of a Semilunar Cartilage.—

Partial or total excision of a semilunar cartilage is generally followed by good functional results. Joints in which the full range of motion was not possible without a dislocation occurring leave full extension and flexion without difficulty. The tone of the muscles improves; the feeling of uncertainty and weakness gradually disappears, so that after a time the joint becomes very useful, trustworthy, and functionally perfect.

Dislocation of the Patella.

Synonym.—Slipping patella.

Etiology.—Dislocation of the patella may be congenital; may be due to a lax condition of the quadriceps extensor muscle; to elongation of the patellar tendon; to direct traumatism; to faulty development of the condyles or patella; to genu valgum, and occasionally to sudden contraction of the extensor muscles of the thigh.

In dislocation the patella may be displaced outward, inward, downward, upward, and vertically. The outward dislocation is the most frequent form.

Congenital dislocation of the patella is usually seen in conjunction with congenital genu recurvatum, and occasionally with congenital genu valgum. The position of the patella in these cases may be upward or outward. When upward, there is usually a lengthening of the patellar tendon; when outward, there may be a faulty development of the external condyle or marked genu valgum.

The majority of cases of dislocation of the patella due to a lax condition of the quadriceps extensor muscle occurring during adolescence, usually in girls with poor muscular development. The patella in these cases is usually dislocated outward.

Dislocation of the patella due to elongation of the patellar tendon is usually seen in conjunction with a generally relaxed condition of the knee-joint, and in some cases other joints may be involved. The patella is always displaced upward, and at times may be upward and outward. This elongation of the tendon may follow an attack of hemiplegia, paraplegia, or anterior poliomyelitis.

A large percentage of cases of dislocation of the patella is due to direct traumatism. A person falling on the knee and striking the outer edge of the patella may receive an inward dislocation of the patella and vice versa. Malgaigne reports a case of outward dislocation of the patella due to a cavalryman striking his knee against that of an opponent while riding past him.

Faulty development of the condyles or patella predisposes to the production of the dislocation, by rendering the planes of the articular surfaces less pronounced, and thereby allowing them to slide by each other with ease.

Weimuth in a report of 66 cases states that 20 are due to genu valgum. In this condition the line of action of muscular contraction of the quadriceps extensor muscle is in a line outside normal and near the external condyle, so that it may be readily seen what part this condition has in the causation of dislocation of the patella. The position of the patella in this condition is always outward.

Occasionally sudden forcible contraction of the quadriceps extensor muscle causes dislocation of the patella. This especially occurs in football-players, wrestlers, etc., when sudden contraction occurs, when the knee is flexed and the leg is rotated outward. It is sometimes seen in runners. The author recalls a case of double dislocation of the patella outward in a boy eighteen years old in whom the condition occurred repeatedly when running.

As a result of the dislocation the capsule is torn to a considerable extent on the side opposite to which the displacement occurs. In outward dislocation the inner side of the capsule is torn along its anterior surface, the edges of the tear and the facial prolongations of the vastus internus are rendered tense, while on the outside the capsule is thrown together in folds which can be felt beneath the skin. The knee is flexed, the leg rotated outward, and at times to relieve the tension on the quadriceps extensor muscle there may be flexion at the hip. The patella is visible and palpable over the epicondyle

and is firmly held in this position. The condition of the capsule and position does not occur when the dislocation is due to laxity of the patellar ligament or quadriceps extensor muscle. When due to the last two causes, the capsule is rarely torn; and when the knee is in full extension, the patella can usually be carried over the external condyle with but little effort.

In vertical dislocation of the patella the displacement is a continuation around a vertical axis of a lateral dislocation, so that the outer edge in outward dislocations and the inner edge in inward dislocations are anterior and the cartilaginous surface of the patella faces outward. The dislocation may continue around a vertical axis until the surfaces are reversed from their normal position.

Symptoms.—Following one of the dislocations enumerated above there is during the first attack sharp pain around the knee, accompanied by an audible click, inability to use the leg, and the characteristic deformity. After reduction there follows an acute synovitis, which rapidly subsides under appropriate treatment, leaving a joint that is liable to subsequent attacks, and which is not so strong as its fellow. A repetition of attacks may occur, so that the function is greatly impaired. When the dislocation results from a lax condition of the joint structures, there is practically little or no reaction.

Prognosis.—The most unfavorable result of dislocation of the patella is its liability to recurrence and the formation of a chronic synovitis. In most instances the patella can be kept from slipping by appropriate apparatus, the one drawback of which is its constant presence and limitation of the motions of the joint. After repeated attacks there results a chronic synovitis, lax condition of the joint structures, the formation of loose bodies from the edges of the capsule, and a functionally imperfect joint. Measures for overcoming the cause and operative treatment offer the best chances of success.

Treatment.—In congenital dislocations of the patella if apparatus fail to hold it in its proper position it may be necessary to replace the insertion of the patellar tendon on the tubercle of the tibia or to reef the capsule. This should not be delayed later than the sixth year for fear that the pressure caused on the condyle might tend to faulty development. In cases due to lax ligaments or poorly developed muscles, massage, electricity, hot air, and exercise should be used, in conjunction with suitable apparatus, to increase the strength of the ligaments and the development of the muscles.

In recent cases due to other causes after reduction the entire limb should be immobilized for two to three weeks and passive motion and massage used

at the end of seven days. When the patient is allowed to use the limb, the knee should be protected by an elastic bandage or knee-cap. These, however, are not as useful in preventing recurrence as the apparatus advised by Bradford, which consists in two pads alongside of the patella which are held in place by steel bands running about the thigh and leg.

The reduction of a dislocated patella is accomplished by flexion of the thigh upon the abdomen and by extension at the knee-joint; this relaxes the quadriceps extensor muscle, and then by manipulation the patella is pushed into its normal position. Some patients who have habitual dislocation of the patella are able to reduce it themselves with very little inconvenience. The vertical dislocations are often difficult of reduction, usually requiring anesthesia and frequently operative interference.

The operation consists in making a longitudinal incision alongside the patella on the opposite side to which displacement occurs; retracting the edges of the wound, and excising an oval shaped piece of the capsule, or in making a reef in the capsule sufficient to prevent a recurrence of the deformity. It is not necessary to open the synovial membrane. The edges of the capsule can be united by mattress sutures of chromicized catgut or silk. The skin wound should be closed without drainage, a sterile dressing applied, and the limb immobilized for four to six weeks, when passive motion may be tried and the patient encouraged to use the limb. When the condition is due to genu valgum, the cure of the displacement will depend upon the result of osteotomy for the correction of the deformity. When the condition results from the traction of the extensors action out of the proper line, the spine of the tibia may be chiseled off and moved to either side according to the desired line of traction wanted. In vertical dislocation where the patella is completely reversed it may be impossible to replace the patella, making excision necessary.

Rudimentary Patella.

Rudimentary patella is usually associated with some congenital defect about the knee-joint. This may consist of a faulty development of the quadriceps extensor muscle, a genu valgum or recurvatum, or subluxation of the upper end of the tibia. At times the patella may be absent or so small at birth as to entirely escape observation. A rudimentary or absent patella renders the joint very weak, there being usually impairment of extension.

Treatment.—This consists in treating the associated condition. Efforts

should be made to overcome the faulty development of the quadriceps extensor muscle by electricity, massage, and passive motion. If genu valgum or genu recurvatum are present, they should be corrected. Most cases require some supporting apparatus.

Snapping Knee.

Synonyms.—Schnellendes or Federmes knee; Genou à Ressort.

Snapping knee is that condition of the knee-joint which consists in a partial displacement backward of the head of the tibia, when the leg, in the act of extension, goes beyond 160 degrees, and is accompanied by a sudden jerk or snap and at times an audible click, and by outward rotation of the tibia. The jerk or snap cannot be made during passive extension. The majority of cases occur in children, but a few are seen in adults.

Etiology.—The exact cause is not known. There is always present a lax condition of the ligaments, and this, combined with sudden muscular action, may account for the condition. It is thought by some to be due to some abnormality in the movement of the external semilunar cartilage, and that it is caught between the articular surfaces, and as the extension goes beyond 160 degrees it is freed, producing the jerk and at times the audible click. In some cases there is the previous history of trauma, dating back several years. As the normal limit of extension is checked by the posterior crucial ligaments it was thought by Thiem to be due to a rupture of these ligaments. Spasm of the flexor muscles and slipping of the biceps tendon have been considered in the causation.

Symptoms.—There may be a history of injury, but in most cases while walking the patient notices, on extending the leg, a sudden jerking movement, which is usually accompanied by pain. The patient, however, is generally able to walk along without difficulty. The deformity, which is rare, is displacement of the head of the tibia backward, and is always reduced without difficulty.

Prognosis.—In children the prognosis is favorable; in adults the condition usually becomes chronic but causes little inconvenience when supported by suitable apparatus.

Treatment.—When the condition can be ascribed to laxity of the ligaments, massage, electricity, and passive motion are beneficial. This should be combined with a suitable elastic bandage, and in some cases a brace will be found necessary.

Elongation of the Patellar Tendon.

Etiology.—An abnormal length of the patellar tendon may be congenital, it may be associated with a laxity of the other ligaments, it may be due to traumatism, and is sometimes seen in anterior poliomyelitis.

Symptoms.—The symptoms are those due to a weak and lax joint. There is early fatigue on exertion, at times disability; in walking up-stairs the patient has difficulty in raising the leg sufficiently high when the knee is semiflexed, and in walking on a level supplements the muscular force of extension by an increased effort at swinging the thigh forward. The patella is usually displaced upward, and with the leg in full extension it can be displaced laterally to a marked degree. It is very often the cause of complete dislocation of the patella. In some instances there is considerable lateral mobility of the knee-joint, due to the general lax condition of all the ligaments.

Treatment.—This consists in massage and electricity to increase the muscular tone and strengthen the ligaments and a brace to prevent lateral mobility of the joint or lateral displacement of the patella. In some cases operative interference is advisable. This is so if the condition is not associated with laxity of the other ligaments. The operation consists in shortening the ligament or in chiseling off the tubercle of the tibia and moving it to a lower position.

Rupture of the Quadriceps Extensor and Patellar Tendons.

Rupture of the quadriceps extensor and patellar tendons is of more frequent occurrence than is generally supposed. It may vary in position and degree.

Etiology.—The cause of rupture is usually muscular action, but may be due to direct injury or disease. When due to muscular action, it usually follows a sudden contraction to prevent falling, or may follow a fall on the feet when the knee is semiflexed. The rupture may rarely be due to direct violence. Vulpus reports two cases due to disease; in the one there was fatty degeneration of the tendon, in the other there was sarcoma of the head of the tibia, so that the patellar ligament was torn off the spine of the tibia.

Rupture of the quadriceps extensor tendon takes place most frequently at its attachment to the patella, rarely in the middle of the tendon, but at times it occurs just above the muscular expansion. Rupture of the patellar tendon takes place most frequently at the attachment to the tibia, next in order at the

attachment to the patella, and very rarely in the middle. The more frequent condition is the separation of the tubercle of the tibia, leaving the tendon intact.

Symptoms.—Usually following sudden forcible contraction of the quadriceps extensor muscle the patient experiences a sharp pain at the seat of rupture, falls to the ground, and is unable to get up or fully extend the leg. Examination shows a gap in the tendon varying from one-fourth to one inch in width; if the patellar ligament is torn, the patella may be drawn upward one to three inches. Following the injury there results an acute synovitis, which may entirely mask the symptoms for a time. When the patellar tendon is ruptured, the capsule of the joint may or may not be torn. This depends upon the position of the rupture, but in most cases the capsule is torn except when the rupture takes place near its attachment to the tibia.

Prognosis.—Usually the torn ends of the tendon are curled up and away from each other and on account of the separation firm fibrous union rarely takes place unless operative treatment is instituted. When treated by mechanical means there usually results impairment of extension, combined with a weak joint and muscular atrophy.

Treatment.—This may be divided into mechanical and operative. The mechanical treatment consists in immobilization on a posterior wire splint in the position of extension and in elevation of the leg so as to relax the quadriceps extensor muscle. The synovitis may be treated by compression. If the rupture is in the patellar tendon, efforts may be made to draw it down in place by means of adhesive plaster passed above it to make traction. At the end of two weeks massage should begin, and at the end of five to six weeks the patient may be allowed on crutches. When the rupture is in the quadriceps extensor tendon, attempts to bring the torn ends together are futile, and the best result that can possibly be hoped for is moderate fibrous union unless operative treatment is adopted. This consists in exposing the torn ends by a suitable incision and suturing the ends by means of chromicized catgut. If the attachment of the patellar tendon is torn off, it may be held in place by periosteal sutures, or a nail may be used to anchor it in position. The wound is closed without drainage, a sterile dressing employed, and a plaster-of-Paris bandage applied from toes to groin. The limb should be kept elevated, massage begun at the end of two weeks, crutches used at the end of four weeks, and the operation should give a perfect functional result.

CHAPTER VIII.

TUBERCULOUS DISEASE OF THE ANKLE-JOINT AND TARSUS.

TUBERCULOUS DISEASE OF THE ANKLE-JOINT.

This is a chronic tuberculous affection of the ankle-joint, having in the majority of cases its primary focus in the astragalus or calcaneum. It is next in order of frequency to that of the knee and is relatively more common in adolescence and early adult life than similar disease of the hip and knee.

Etiology.—Added to a constitutional predisposition, the disease is usually excited by traumatism and by exposure to dampness or cold. When we consider that the ankle-joint is more frequently the seat of injury than any other joint in the body, it is remarkable that it is not more frequently affected by tuberculous osteitis.

Pathology.—The pathologic changes met in tuberculous ankle-joint disease are similar to the conditions found in other joints. The disease may have its primary focus in the lower end of the tibia, fibula, or any bone of the tarsus. While older writers claim that the disease may be primary synovial, the investigations of Nichols lead one to believe that with more thorough search of the osseous portions of the ankle the percentage of primary synovial involvement will be reduced to a minimum. On account of the extensive communication of the synovial membrane of the joints of the foot and their proximity to the ankle, extension following primary involvement of the tarsal bones, may lead quickly to invasion of several joints, and at times the ankle-joint. In this case the bones of the foot and ankle become rapidly surrounded by masses of tuberculous material, rendering the situation of the primary focus very difficult and in most cases impossible to find. Abscess formation is more common in ankle-joint disease than in other joints.

Statistics.—In 5680 cases treated at the Orthopedic Department of the Hospital of the University of Pennsylvania, there were 44 cases of this affection. Mondan's report of 117 cases from Ollier's clinic states that the disease was primarily osseous in 114, primarily synovial in 3, and doubtful in 25 cases. Hann reported 907 cases collected from various statistics (Audry, König, Mondan, Münch, Spengler, Vallas) and from some cases observed at v. Bruns' clinic.

Of these, the disease was primarily osseous in 68.7 per cent., primarily synovial in 31 per cent., and in 74 cases it was impossible to determine the original focus. In his report of 704 cases treated at Tübingen, covering a period of fifteen years, there were 309 cases in which the ankle-joint was diseased, the primary focus being in the internal malleolus in 11 cases, in the external malleolus in 7 cases, in both malleoli in 5 cases, and the astragalus was primarily involved in 116 cases. The remaining 49 per cent. were of synovial origin. In 16 cases the disease was secondary to a focus in the os calcis, and in 5 cases the os calcis and astragalus were conjointly involved. Vallas, in reporting 71 cases operated on by Ollier, states that the original focus was in the astragalus in 22, in the calcaneum in 13, the scaphoid in 3, the cuboid in 1, in the malleoli in 9, and was primarily synovial in 23 cases.



FIG. 359.—ANKLE-JOINT DISEASE (Barwell).

The tendency to abscess formation is much greater in ankle-joint disease than in that of the hip or knee. Prendlesburger's statistics give 87 per cent. and Gibney 83 per cent.

Symptoms.—The onset of this disease is very insidious, but the cardinal symptoms of chronic joint disease may be early recognized. These are muscular spasm, atrophy, lameness, the peculiar attitude of the limb in walking and standing, pain, swelling, and the occurrence of abscesses. Lameness is an early symptom, at first a little soreness or stiffness in the joint after exercise, later increasing in severity, and aggravated by walking or motion. The swelling at first appears at the sides of the extensor tendons and later behind and below the malleoli, obliterating the normal outlines of the joint. At first the foot is movable, but usually held in extension, adduction, and inversion; later it becomes fixed in this position. No lateral displacement occurs except when the joint structures are disorganized. Pain is not a constant symptom, but the entire joint may be exquisitely sensitive to pressure and accompanied by "night cries." When suppuration occurs, the abscesses point in the direction of least resistance, either anterior or posterior to the malleoli.

Disease of the astragalus is usually classified with ankle-joint disease, as in only 8 instances out of 170 cases of disease of the astragalus did the ankle-joint remain intact (Hahn). While the symptoms at first may differ slightly from those of ankle-joint disease, the latter is so soon involved that differentiation

becomes impossible. When secondary involvement does not occur, the swelling is below the ankle-joint and midway between the malleoli. Flexion and extension are generally not impaired.

Diagnosis.—The disease can be easily recognized by attention to the foregoing symptoms, but the affection must be distinguished from tenosynovitis, functional affections, acute articular rheumatism, infectious arthritis, and sprains.

In tenosynovitis the swelling and tenderness are localized along the course of the tendons. Pain is only present on motion; there is no muscular spasm or deformity, and in most cases crepitation can be felt over the affected tendons on voluntary motion.

Functional affections may simulate to some extent tuberculous ankle-joint disease, but are distinguished from the latter by the absence of muscular spasm, of swelling, local signs of inflammation, and by the fact that all symptoms are subjective.

In sprains the symptoms are acute, there is the history of injury, swelling is always below and behind the malleoli; there is no deformity or passive limitation of motion.

Acute articular rheumatism is differentiated by the presence of fever, involvement of other joints, and its subsidence under the salicylates.

In infectious arthritis there is usually the history of a wound or a septic process elsewhere, temperature, lymphangitis, local heat, and rapid onset.

Prognosis.—The course, duration, and termination are partly influenced by the age of the individual. In children recovery is the rule without surgical interference, while in adults operative measures are necessary in many cases. The final result in children is good. Under conservative measures children very often retain considerable motion at the ankle-joint, especially if the astragalus is not involved; and when this is diseased the motion at the ankle is supplemented by the joints of the foot. Shortening is not marked and rarely amounts to more than $\frac{1}{2}$ to $\frac{3}{4}$ of an inch.



FIG. 360.—TUBERCULOUS ANKLE-JOINT DISEASE, WITH MENINGITIS.

Treatment.—Tuberculous disease of the ankle-joint in most cases yields readily to conservative treatment, and while traction is inapplicable on account of the anatomic peculiarities of the joint, the other two principles of conservative treatment, fixation and protection, are followed by very gratifying results.

Conservative treatment.—In the acute stages it may be wise to put the patient to bed and elevate the limb if much swelling is present; and while children do well in bed for a long time, adults improve more rapidly in the open air. Fixation should be secured by the application of a plaster-of-Paris

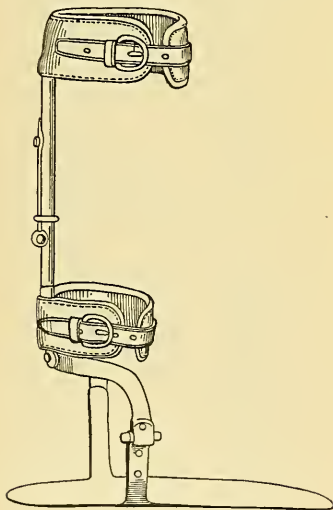


FIG. 361.—FOSTER ANKLE BRACE.

splint reaching from the toes to just below the knee, and in some cases it may be advisable to fix the knee-joint. Protection is afforded by a high sole on the sound foot and crutches. No weight should be borne on the diseased side, so in some cases the possibility of this can be guarded against by the use of a splint which transfers all the weight to the tuber ischium. A Thomas knee splint is very suitable for this purpose. Very often patients are not seen until the deformity has become well marked. In these cases the deformity may be corrected gradually or rapidly. It is corrected gradually by the successive application of plaster-of-Paris bandages from the toes to the knee every week. After one or two weeks the muscular spasm will have lessened to such an

extent as to render correction painless and easy. In some resistant cases the deformity can be corrected rapidly under anesthesia. In the application of plaster-of-Paris and other splints the greatest care should be exercised to keep the foot and ankle in good position, as in the early stages deformity is readily corrected. This is not so in the late stages, and to prevent this malposition should be the object of the splints. Plaster-of-Paris is the best material for these splints, as it is rapid in application, fits the parts accurately, and can readily be renewed. A new bandage should be applied every three to four weeks. Very good results have followed the injection of iodoform glycerin (10 per cent.) directly into the joint. The place of puncture should

be at the sides of the extensor tendons. As abscesses form they may be treated in a similar manner. Bier's method of passive congestion may be used in treating tuberculous ankle-joint disease, and while it is only in its initial stage, good results are expected of it.

Conservative treatment should be tried in children as long as the patient's general health remains good. Abscesses and fistulas often heal either by injection with iodoform emulsion or cureting out the cavity or fistula. Operative measures are to be considered when there is high fever, profuse suppuration, evidences of failing of the general health, or the appearance of tuberculosis of other organs. Maas, in König's clinic, advised operation in children if at the end of two months marked improvement had not occurred. In adults conservative treatment does not give as good results as in children. The appearance of suppuration is a positive indication for operative treatment.

Operative treatment.—Under the operative treatment are classed, (1) curetage; (2) resection; and (3) amputation.

1. Curetage: While the cureting of sinuses and abscesses in children may be done with little risk, in the adult the results are not so good, and this procedure is often followed by rapid involvement of surrounding structures and occasionally by a rapid general tuberculosis. Very often by this method considerable amounts of healthy bone are removed that otherwise might not have become involved. This procedure should be limited to children and to adults until the stage of convalescence, when it may be used to remove sequestra and tuberculous sinuses. It is contraindicated in adults during the acute stage of the disease.

2. Resection: The indications for resection have greatly increased and its results have been much better during late years. Formerly surgeons, on account of the poor functional results obtained, feared to remove the tuberculous area thoroughly. Of late, however, any method which completely eradicates the diseased areas, even if the functional results are not satisfactory, is considered preferable to amputation. The latter is advisable when the patient's general condition will not endure a prolonged convalescence and when the age is well advanced. Osler considers the mortality of resection at 5 per cent. up to the fifteenth year; at 10 per cent. between twenty and twenty-five years, and at 19 per cent. beyond twenty-five years. Other contraindications to resection are, rapidly growing tuberculosis of the lungs, amyloid degeneration of the viscera, very marked secondary infection, and general weakness.

In resection a better functional result is obtained if the malleoli are pre-

served. The old methods of resection of v. Langenbeck and Bourguery are no longer used, on account of the great amount of bone sacrificed and the instability of the resulting joint. König's method preserves the malleoli. Kocher's and Lauenstein's method allows the entire joint to be inspected, as the joint can be readily dislocated and a thorough examination of diseased structure is possible. Of all the methods used from time to time, that of Kocher has given the best results. It is as follows: Bleeding may be controlled by a tourniquet. A curved incision is made on the external surface just behind and below the external malleolus and is carried forward from the tendo Achillis to the extensor tendons. The peroneal tendons are cut and the ends secured. The lateral and capsular ligaments are divided. The foot is dislocated inward, the capsule of the joint incised, and the cavity thoroughly inspected. All diseased tissue should be thoroughly removed. The astragalus is in most cases diseased and should be removed; portions of the tibia may require removal. The wound may be closed, but it is advisable in most cases to pack with iodoform gauze. A sterile dressing and plaster-of-Paris bandage should then be applied from the toes to the knee, attention being paid to keeping the foot at right angles to the leg and mid-way between inversion and eversion. A window may be cut through the plaster-of-Paris splint to facilitate dressing.

3. Amputation: While resection may be considered as a conservative operative method, in many cases it fails and is contraindicated by the development of general miliary tuberculosis, poor general condition, age, and lack of resisting powers. In this class of cases amputation is necessary.

As this radical measure is called for by the urgent condition of the patient, the chief point to be considered is the removal of the diseased area so as to shorten convalescence. To do this, the point of amputation should always be in healthy tissue and the stump should be such as to heal by primary intention. The method of amputation is left to individual choice and may be found in works on general surgery.

Statistics on treatment. Under conservative treatment Gibney noted the results in thirty cases as follows:

1. The minimum duration was one year.
2. The maximum duration was six years.
3. The average duration was three years and three months.
4. The average time under treatment was one year and three months.
5. Extensive suppuration occurred in nineteen cases.
6. Moderate suppuration occurred in six cases.

7. No suppuration occurred in five cases.
8. Twenty patients recovered without any limp and six had very slight limp.
9. There were usually shortening and atrophy of the calf muscles when the disease occurred in children.
10. In three cases there was resulting deformity in the foot.
11. There were two deaths, one of which was due to the disease.
12. Six patients recovered with normal motion, eleven with practically normal motion, and in seven the motion was fair. Ankylosis occurred in six cases.

The most valuable statistics of cases treated by resection are those of Connor. His report includes 108 cases treated by resection. In 47.37 per cent. the results were good; in 10.53 per cent. there were failures; 24.21 per cent. could walk without limping; and 6.32 per cent. could walk with a cane. Shortening, while present in all the cases, was slight in the majority.

Maas reported 102 cases from König's clinic. Of these, 87 were operated on by König's method, in 48 astragalectomy being performed. Forty-two of these cases were examined at a late period after the operation and in all the functional results were good, there being no tendency to deformity or weakness at the joint. The shortening in these cases averaged $3\frac{1}{2}$ inches, which was in marked contrast to 11 cases operated on by v. Langenbeck's method, in which the shortening averaged $5\frac{1}{8}$ inches and only one recovered with a good functional result.

Resection of the astragalus, which is usually necessary in tuberculous disease of the ankle-joint, is generally followed by little or no impairment of function; the shortening is very little increased, and if the malleoli are not removed the results are good.

TUBERCULOUS DISEASE OF THE TARSUS.

The joints of the foot are often the seat of tuberculous disease without similar involvement of the ankle-joint. From the statistics of 1231 cases reported by Hahn the frequency of involvement of the bones of the foot and ankle is as follows: Calcaneus, 339 (25.9 per cent.); astragalus, 291 (23.6 per cent.); cuboid, 154 (12.5 per cent.); scaphoid, 110 (8.9 per cent.); cuneiforms, 109 (8.8 per cent.); metatarsals, 110 (8.9 per cent.); malleoli, 96 (7.7 per cent.); and phalanges, 22 (1.7 per cent.).

On account of the proximity of the joints of the foot disease of one joint

is rarely self-limited,, but spreads rapidly to other joints. As a result many of the tarsal bones are affected early, and the entire tarsus and surrounding structures are involved early and converted into a tuberculous mass, so that bony outlines are lost and it soon becomes impossible to distinguish the primary seat of the disease. Hahn, from v. Bruns' clinic, reports 170 cases of the astragalus in which the ankle-joint remained intact in only 8 instances; and in 386 out of 704 cases limited to the foot and reported by the same author. the mediotarsal joint was affected in 141 instances, and in 91 of these extension of the process continued to other joints; in 46 the ankle, in 29 the tarsometatarsal and in 16 the three joints were involved. In only 50 instances was the disease self-limited to the joint in which it commenced. Of 78 cases of involvement of the tarsometatarsal, 33 were self-limited.

The calcaneum is the most frequently involved bone of the foot. It is remarkable on account of the large sequestra formed and on account of the infrequency of joint involvement; the calcaneo-astragaloid joint being most frequently attacked. Mondan's statistics show joint involvement in 26 of 40 cases, and of these 26 the calcaneo-astragaloid joint was involved. Statistics from v. Bruns' clinic show joint involvement in 87 of 200 cases of tuberculous disease of the calcaneum.

In disease of the calcaneum the swelling of the soft parts is limited to the heel and the bone is thickened. As the calcaneo-astragaloid joint becomes involved the swelling extends higher and more forward toward both malleoli, eversion and inversion are painful and attended by slight muscular spasm. Flexion and extension are not altered.

In astragaloid disease the swelling occurs either below the malleoli and simulates primary disease of the os calcis with involvement of the calcaneo-astragaloid joint, or if the focus is on the anterior surface the swelling first appears on the dorsum of the foot just beneath the ankle-joint and mid-way between the malleoli. Usually, however, the ankle-joint becomes involved very early, and as a result it is impossible to distinguish the condition from primary disease of the ankle-joint.

In disease of the cuboid and scaphoid the swelling is first noticed on the inner or dorsal surface of the foot, but there is a tendency to rapid involvement of the base of the four last metatarsals and the anterior surfaces of the astragalus and calcaneum. The disease may begin in the first metatarsal or internal cuneiform bones and be limited to these two for some time on account of the non-communication of the joint with the other tarsal joints.

After the disease has advanced to a certain stage it is practically impossible to say where the primary focus was situated. The swelling spreads so rapidly on account of the arrangement of the mediotarsal and tarsometatarsal joints that very soon the soft parts are converted into a mass of tuberculous material which eventually destroys the outline of the bones. Abscesses usually occur and may rupture on the inner side, generally on the dorsum and rarely on the plantar surface. They generally become very large and involve the entire sole before they rupture; or they may work their way through and rupture on the dorsum. This is due to the dense fascia on the sole of the foot.

In tuberculosis of the metatarsals and phalanges the disease is usually multiple. In adults there is a tendency for the involvement to take place at the metatarsophalangeal joints.

Treatment.—On account of the arrangement of the structures involved in tuberculous disease of the tarsus there is a marked tendency for rapid extension. Operative treatment is always advisable. In disease of the calcaneum foci should be removed by chiseling, and if the destruction of bone is extensive the osteoplastic resection of v. Mikulicz is advisable.

Disease of the astragalus usually necessitates astragalectomy and at times resection of the joint. This may be performed by Kocher's, Lauenstein's, or König's methods.

In disease of the tarsal bones if the process has not extended, resection of the bone involved may check the disease. This should be the rule in children. Anterior tarsectomy should, however, be performed in adults if the disease is at all extensive, as the growth of the bones would be insufficient to prevent deformities by simple resection.

Involvement of the metatarsals and phalanges calls for removal of the metatarsals and amputation of the toes, as the resulting cicatrices in conservative treatment of the latter often prove troublesome.

In all cases when the disease is very extensive and there are no contraindications to conservative treatment the latter may be tried for a time, especially in childhood. In adults, however, the result obtained is so poor in most cases that amputation is preferable not only in the time gained, but also in the usefulness of the stump, to which an artificial foot may be attached. When any contraindications are present amputation should be performed, as the loss of the foot is more than amply compensated by the shortened convalescence, the usefulness of the part, and the slight risk incurred by operative interference.

CHAPTER IX.

NON-TUBERCULOUS DISEASES OF THE ANKLE-JOINT.

Acute Sprain of the Ankle-joint.

An acute sprain is the term used to denote the condition produced by traumatism which ordinarily would result in fracture or dislocation of the ankle-joint. The force, while it is probably not sufficient or not applied in the right direction to cause fracture or dislocation, yet causes tears of the synovial membrane or extensive laceration of the ligaments, especially the lateral. Inversion and eversion at the ankle-joint are not possible except in extreme extension, and then only to a very slight degree; when, however, the weight of the body is thrown upon the foot while it is in a position of inversion or eversion, which movements take place at the mediotarsal joint, fracture of either malleoli, dislocation, or sprain occurs. Sprains by inversion are produced when the foot is inverted, supinated, and extended. The force therefore falls upon the external lateral ligaments. Sprains by eversion are produced when the foot is everted, pronated, and flexed. While a sprain occurs in this manner, it is more frequent, however, for a fracture of the internal malleolus result on account of strength of the internal lateral ligaments. Sprains by inversion are very often accompanied by some tears of the ligaments between the calcaneum and cuboid and scaphoid and cuneiform bones.

Symptoms.—Immediately following a twist upon the ankle there is severe pain, tenderness on pressure, and rapid swelling takes place. The swelling is below and anterior to the external malleolus in sprains by eversion and in a similar relation to the internal malleolus in sprains by inversion. Involvement of the tarsal joint is recognized by the localized swelling, tenderness, and pain. In severe cases the swelling may involve the entire circumference of the foot, ankle, and lower half of the leg. Severe sprains are characterized by ecchymosis, which may be very extensive and usually appears in twenty-four hours.

Diagnosis.—This rests upon the history of injury, swelling, pains, tenderness, ecchymosis, and absence of faulty position and crepitus. The condition is to be differentiated from fracture of the malleoli by the position of the initial

swelling, which is always confined to the limits of the synovial membrane, whereas in fracture the primary swelling, being due to an exudation of serum and blood at the seat of fracture, is usually situated $\frac{1}{2}$ inch to $1\frac{1}{2}$ inches above the tips of the malleoli. In sprain there are absence of crepitus, abnormal mobility, and deformity, and the tenderness is generally at the tips of the malleoli. After twelve to twenty-four hours there may be considerable difficulty of diagnosis, which will be overcome by x-ray examination.

Treatment.—In reference to treatment sprains may be classified as slight and severe. Slight sprains, if seen immediately before any infiltration of the tissues has taken place, should be treated by compression, rest, and fixation. Compression may be obtained by an elastic bandage extending from the toes to the mid-leg. The patient should be put to bed and the foot supported by sand-bags. At the end of twenty-four hours massage may be used and the ankle supported by Cotterell's adhesive plaster dressing or a light plaster-of-Paris bandage extending from the toes to just below the knee. The adhesive plaster dressing allows moderate use with fixation. It can be changed every three or four days, and at the end of ten days may be replaced by a flannel bandage. The plaster-of-Paris bandage may be split down either side and removed daily for massage. It should be discarded in ten days and a flannel bandage applied. In severe cases the joint should be placed at absolute rest for two to three weeks. Fixation is best accomplished by keeping the patient in bed with the foot immobilized in a fracture box or until the swelling has subsided, and then a plaster-of-Paris bandage should be applied from the toes to just below the knee and the patient allowed the use of crutches. At the end of two weeks passive motion which will not tend to stretch the involved ligaments may be given in addition to the massage, and at the end of three weeks the plaster splint may be discarded, a flannel bandage applied, the patient should be encouraged to use the leg, and in addition to massage and passive and active motion, baking of the joint with hot air may be used every other day. Such prolonged treatment is advisable in severe cases of sprain to allow complete repair of the torn ligaments and to prevent the general weakness and recurrence of the condition which follow hasty and rapid treatment.

Chronic Sprain of the Ankle-joint.

Chronic sprains of the ankle-joint may be due to a weakness or stretching of the ligaments as a result of an acute sprain. Many cases are due to a lack of repair at the point of rupture in acute cases, so that there results marked

increase of the normal lateral motion at the joint and considerable instability of the foot. It is synonymous with traumatic flat-foot, which results from an acute sprain of the mediotarsal or calcaneo-astragaloid joint. It is sometimes seen following prolonged fixation in splints or from disuse. At times the effusion of an acute attack may not be entirely absorbed, or may result in adhesions which in time limit flexion and extension and cause a certain amount of muscular fixation. Through fear of injury some patients refuse to use the joint after an acute attack, and as a result the foot assumes a faulty position, atrophy of muscles takes place, adhesions occur, the soft parts about the ankle remain congested and edematous, so that the acute condition is very liable to become chronic.

Symptoms.—The patient complains of a weak, unstable joint, which is continually “turning under him” in unguarded moments. The soft parts about the ankle are swollen, there may be slight tenderness on pressure, normal flexion and extension may be limited on account of adhesions, while lateral movements are increased. The synovial cavity is distended and marked fluctuation present. The foot is generally held in a position of equino-valgus. Involvement of the mediotarsal or calcaneo-astragaloid joints causes marked tenderness along the inner and plantar surfaces of the foot and back of the leg. This is accompanied by flattening of the sole of the foot.

Treatment.—This consists in restoring the normal function of the joint as much as possible. Massage, baking with hot air, active and passive motion, should be given in all cases to restore muscular tone and break up any adhesions that may be present. If the foot is held in an abnormal position and the normal joint motions markedly restricted they should be corrected gradually or in some cases under anesthesia. If the deformed position is marked, after correction a plaster-of-Paris bandage should be applied to hold the foot for a time in an exaggerated opposite position. After removal of the plaster bandage recurrence of deformity may be prevented by a suitable walking brace. Traumatic flat-foot should be treated by appropriate foot plates, massage, and active and passive movements of the foot. In all cases gradual use of the foot with suitable protection, as an ankle support, should be encouraged.

Tenosynovitis.

The sheaths and their inclosed tendons about the ankle-joint may be subject to acute, chronic, and tuberculous inflammation. As an acute affection it may accompany sprains of the ankle or may be due to excessive use of a group or groups of muscles connected with the tendons. This is sometimes met

in skating or any similar exercise. It may be due to rheumatic diathesis or an acute infection. Chronic tenosynovitis is met as a result of recurrent acute attacks, rheumatism, gonorrhea, and infectious diseases. Tuberculous tenosynovitis sometimes occurs apparently without any involvement of other structures.

Pathology.—In the acute stage the sheath is congested and distended with serous fluid, containing a moderate amount of fibrin, which later produces adhesions between the tendon and its sheath, the rupture of which produces crepitation characteristic of the affection. In the chronic varieties there is thickening of the sheath, a variable amount of fluid, adhesions, and in the tuberculous variety rice bodies.

Symptoms.—The symptoms of acute tenosynovitis are pain, on muscular action, tenderness, limited to the involved areas, on pressure, swelling, and crepitation on active motion. In the chronic form the foot assumes various deformed positions, there is moderate muscular atrophy, and there are swelling, localized thickening, and fluctuation over the involved sheath. Tuberculous tenosynovitis is accompanied by very little pain, no limitation of motion, at times there may be localized crepitus, and the presence of rice bodies can often be felt.

Treatment.—In acute tenosynovitis the treatment consists in compression; counterirritants, as tincture of iodine, cantharidal collodion, or the cautery; and fixation by means of a Cotterell adhesive plaster dressing or a plaster-of-Paris bandage extending from the toes to the knee. The splint should completely prevent all muscular action in the leg. This treatment should be supplemented by large doses of sodium salicylate, as these cases improve very rapidly under the salicylates. After immobilization from five to six days, massage, baking with hot air, and passive motion should be instituted, and support given with a flannel bandage. Chronic tenosynovitis may yield to the above treatment, but in persistent cases it may be necessary to remove the affected sheath. Tuberculous tenosynovitis calls for complete removal of the sheath or sheaths affected.

CHAPTER X.

TUBERCULOUS DISEASE OF THE SHOULDER-JOINT.

Of all the major joints, the shoulder is among the least frequently affected by tuberculous disease. This may be accounted for, possibly, by the part traumatism plays as an exciting cause of this condition; yet aside from this, it is difficult to say anatomically why the head of the humerus should be affected so little when compared with the head of the femur. Thus in 5680 cases of orthopedic affections treated in the Orthopedic Department of the Hospital of the University of Pennsylvania there were only 7 cases of this affection.

Statistics.—Ollier states that Crocq saw one case in 140. Billroth observed 28 cases of tuberculous shoulder-joint disease in 1996 cases. Townsend states that in 3244 cases of bone and joint tuberculosis observed at the Hospital for ruptured and crippled from 1899 to 1893 the shoulder-joint was involved in 21 instances. Whitman records 1833 consecutive cases of joint disease—excluding Pott's disease—treated in the out-patient department of the same hospital during five years, in which the shoulder-joint was involved in 38 instances.

Age.—Townsend, in his 21 cases, observed that the average age at the time of onset was twelve years; the youngest patient was three and a quarter years, the oldest thirty-five years. Whitman's statistics of 62 cases showed the average age to be a little higher than Townsend's; the youngest was one year, the oldest fifty-six years.

Of the twenty-one cases reported by Townsend, in five there existed tuberculosis of other joints; one had Pott's disease; two had disease of the hip and two knee-joint disease; but in these five cases the disease of the shoulder was secondary to that of the other joints.

Pathology.—The pathologic change which takes place here is similar to that of other joints. The primary focus is generally in the head of the humerus.

The most common form of tuberculous shoulder-joint disease is caries sicca, consisting of a gradual destruction of the head and the formation of granulation tissue. This form may be so extensive in some cases that not only is the head destroyed but part of the shaft may be involved. This usually

occurs without the formation of abscesses. When the tuberculous process extends into the medullary cavity of the shaft, the process is termed *caries carnea*. Mondan and Audry record abscess formation in 33 of the 40 cases of tuberculosis of the shoulder-joint. When this occurs, numerous sinuses are formed by the joint contents finding their way along the long tendon of the biceps, to open on the surface of the arm, below the anterior fold of the axilla, or perforating the joint capsule, escape beneath the deltoid muscle, to present themselves in the inter-muscular septum between the deltoid and the pectoralis major in front of or between the shoulder and the scapula behind.

Symptoms.—In most cases without any history of injury being present there is noticed on rising in the morning slight pain about the shoulder, which may be referred down the arm, is considered to be of neuralgic character, and disappears after several hours. This symptom returns, with increasing severity daily; the localized and referred pains increase in amount and are greatly aggravated by motions which are caused irrespective of the scapula. Soon there appears local tenderness, which is particularly marked in the axilla and posteriorly. Swelling is an early symptom and is shown by increased circumference of the shoulder. This swelling shortly gives way to flattening of the shoulder, which is caused by atrophy of the deltoid muscle in the early stages and in the *caries sicca* variety by atrophy of the head of the humerus. Limitation of motion is present from the beginning, and while the patient may use the shoulder to a moderate degree, he is able to do so on account of the normal mobility of the scapula. Muscular spasm is an early symptom, and when atrophy of the head occurs, the proximal end of the shaft may be drawn up and inward so as to produce prominence of the acromion process of the scapula, and in some cases the deformity will be so great as to resemble a subcoracoid dislocation. When abscesses form, there are swelling of the soft parts about the shoulder, increased local and general temperature, and rigors, and burrowing of pus takes place.

Diagnosis.—This affection must be distinguished from primary bursitis and rheumatoid arthritis limited to the shoulder-joint. Inflammation of the bursæ beneath the tendons of the subscapularis and infraspinatus muscles is usually secondary to shoulder-joint disease, but when primary, pain will be elicited by drawing the arm away from the scapula and rotating it from side to side, and the essential symptoms of joint disease so often described will be absent. In primary bursitis of the sac beneath the deltoid muscle all the movements of the arm will be painful with the arm hanging by the side. Rheu-

matoid arthritis is a disease of advanced life, the head of the humerus is elevated and advanced forward, crepitation is present in the joint, without suppuration, rigors, fever, sweating, or other symptoms of tuberculous joint lesion.

Prognosis.—Unless the disease be early arrested, the destruction of the head of the humerus will be excessive and atrophy of the muscles great. The prognosis is not so favorable as in other large joints. This is due partly to the fact that the average age is greater, many cases occurring in adults, and that a large percentage are complicated by pulmonary tuberculosis. The advent of suppuration increases the gravity of the prognosis. Under favorable circumstances caries sicca tends to spontaneous cure, by ankylosis, in from two to three years. The results of conservative treatment are excellent.

Treatment.—The indications for treatment of tuberculous shoulder-joint disease are the same as those of other joints, namely, rest, fixation, and protection. The elbow should be flexed, the forearm placed in a sling, and the arm held to the side, by some dressing, as adhesive plaster. The weight of the elbow will serve as traction. In some cases it may be necessary to immobilize the entire upper extremity by means of a plaster-of-Paris bandage. If muscular spasm and pain are extreme, they may be relieved by supporting the arm at a right angle to the body, as advised by Monks. This may be done by means of a plaster-of-Paris bandage or a wire splint made so as to hold the arm away from the chest. This position materially relaxes the deltoid muscle and other joint structures, relieves the tension on the nerves, and aids by means of the weight of the arm in separating the articular surfaces.

A large majority of cases will recover under conservative treatment. This is partly due to the fact that the joint is well protected from injury and can readily be put at rest. This is possible because a considerable change of movement of the shoulder may take place without the head of the humerus moving in the glenoid cavity, on account of the free mobility of the scapula.

When abscesses form about the shoulder, they may be aspirated and injected with iodoform emulsion or irrigated with a carbolic acid solution (3 to 5 per cent.). If mixed infection is present, the suppurating area should be incised and drained. In children arthrectomy may be necessary. This should be preferable to resection, as very often the tuberculous area may be removed without destroying the entire head of the bone. In adults when conservative treatment has failed and the general condition is bad, resection offers the best functional results. This operation consists in making an anterior longitudinal incision down to the periosteum, dividing

the latter, and separating it from the bone as much as possible by rotation of the arm; the head of the bone and as much of the shaft as is diseased can be removed by a chisel or saw, or the head may be brought out through the wound and excised. All tuberculous tissue of the glenoid cavity and capsule of the joint should be thoroughly removed. The wound may be closed in the hope of obtaining primary union, or a small gauze drain may be inserted. Position and fixation should be obtained by proper padding and the application of a plaster-of-Paris bandage. At the end of three to four weeks passive motion and massage should be instituted. This, however, should be moderate, lest a flail joint be produced, ankylosis being preferable.

Amputation is advised when marked cachexia is present, when suppuration is very extensive, and in those cases in which, on account of the marked destruction of the shaft,—as in *caries cariosa*,—the resulting arm would be entirely useless.

Injections of iodoform-glycerin (10 per cent.) and passive congestion by Bier's method as supplementary to mechanical treatment have been found of value. Tincture of iodine, cantharides, and the Paquelin cautery may be used locally in the early stages. The general health should be improved by cod-liver oil, hypophosphites, iron, quinin, malt liquors, and other tonics.

During convalescence gradual passive motion combined with massage and baking with hot air will be of benefit in reducing the amount of fixation due to adhesions. If the limitation of motion is very marked, it may be forcibly overcome by manipulations under anesthesia. Passive motion, however, should not be attempted until all muscular spasm has ceased.

CHAPTER XI.

NON-TUBERCULOUS DISEASE OF THE SHOULDER-JOINT.

Subdeltoid Bursitis.

Inflammatory conditions of the subdeltoid bursa may be acute, chronic, tuberculous, or suppurative in character. This bursa is situated between the deltoid and supraspinatus and infraspinatus muscles and the coraco-acromial ligament.

Acute subdeltoid bursitis is usually due to injury and consists of an acute serous effusion which at times may contain a varying amount of blood. It is sometimes seen in connection with inflammatory conditions of the sheath of the biceps tendon.

Chronic subdeltoid bursitis, first described by Duplay in 1872 under the name of "periarthriti humeroscapularis," is due to direct or indirect traumatism or occurs as a result of gonococcus infection or rheumatism.

Tuberculous subdeltoid bursitis may be primary or may be due to a secondary involvement by extension from the shoulder-joint. Its most striking characteristic is the presence in the deltoid region of a swelling which may reach the size of a grape-fruit and simulate malignant or benign growths.

Suppurative subdeltoid bursitis is usually seen following a pyogenic infection of the shoulder-joint or an acute suppurative epiphysitis or osteomyelitis.

Symptoms.—The most marked symptom is a fluctuating swelling limited to the deltoid region. In the acute, chronic, and tuberculous varieties pain and tenderness on pressure are very slight. In the suppurative variety there are pain, tenderness, redness of the overlying skin, and subjacent edema present. In the tuberculous form the swelling may become very large, so as to simulate malignant or benign growths, as sarcomata or lipomata. Movements of the arm which cause the swelling to become very tense are painful, and there may be referred pain down the arm to the fingers.

Diagnosis.—This rests upon the history, the localization of the swelling to the deltoid region, in most cases the absence of involvement of the shoulder-joint, and in the suppurative variety the presence of a primary focus of infection.

The condition should be carefully differentiated from tenosynovitis of the biceps tendon, from shoulder-joint affections, and from malignant and benign growths.

Treatment.—In the acute and chronic forms this consists in putting the part at rest, the use of counterirritants, and the use of massage and electricity when the acute symptoms have subsided. The tuberculous variety is treated upon the same general principles as tuberculous disease of other bursæ. The suppurative variety requires incision and drainage.

Acromial Bursitis.

Inflammation of the acromial bursa usually is due to an occupation necessitating the carrying of heavy burdens upon the shoulder, as seen in hod-carriers. Enlargement of this bursa rarely gives rise to subjective symptoms. It is characterized by the presence of a round, fluctuating, non-tender swelling over the acromion process of the scapula. Motion at the shoulder-joint is not affected by its presence. If it gives rise to subjective symptoms, or if it undergoes suppuration, it may be dissected out from the surrounding structures or incised, and its cavity then thoroughly cureted and drained. Similar inflammatory changes may take place in the subscapular, subcoracoid, and subserrate bursæ.

Loose Shoulder-joint.

By the term loose shoulder-joint is meant the lax condition found as a result of inflammatory and destructive processes or paralysis. It is seen when there has been considerable destruction of the head of the bone following gunshot wounds, fractures, and resection. It may result from inflammatory processes causing entire disorganization of the joint, as purulent arthritis. It may accompany Charcot's disease and syringomyelia. It may follow injuries to the brachial plexus, circumflex and subscapular nerves. It may follow injuries received at birth, as epiphyseal separations and fractures, or may be due to infantile paralysis.

Symptoms.—The symptoms of loose shoulder-joint are essentially those of a relaxed joint. This laxity varies to a marked degree according to the cause. It may be very little more than normal or in some cases may be so great that there is a well-marked space between the acromion process of the scapula and the head of the humerus. The acromion process is very prominent, being due to the atrophy of the surrounding muscles, especially the deltoid.

and the inability of the head of the humerus to assist in forming the normal contour of the shoulder. The arm in some cases may be very useful up to a certain point in abduction when the dislocation occurs, or in some cases it may hang at the side, rotated inward, with the hand pronated, and be perfectly powerless as far as motions at the shoulder are concerned. In some cases the best motion that can be obtained consists in a swinging movement of the entire arm. The head of the humerus in some cases is in fairly good apposition to the glenoid cavity, in others it may be separated from it by several inches. By passive movement the head may readily be displaced in all directions.

Prognosis.—The prognosis is exceedingly poor. The condition, even with operation, becomes progressively worse, so that after a time the entire arm is useless.

Treatment.—The treatment of this condition may be mechanical or operative. The mechanical treatment consists in an appropriate apparatus which limits abduction and elevation and at the same time holds the head of the humerus in the best possible position. All these apparatus consist of an arm-piece made of cloth, leather, or some similar material, strengthened with steel bands. The arm-piece is continued over the shoulder antero-posteriorly and to the base of the neck. The shoulder portion is continued down the chest and passes completely around it to the opposite axilla. A steel bar runs from the base of the neck over the joint of the shoulder and down to the external surface of the arm. Opposite the shoulder there is a joint which allows antero-posterior motion but prevents abduction and elevation. Among the most trustworthy apparatus are those recommended by Hoffa, Billroth, and Collin.

Attempts may be made to secure ankylosis by removing the articular cartilages and in some cases a portion of the epiphysis. This has been performed by Wolff and Karewski. The head of the humerus may be sutured to the glenoid cavity by means of silver wire. Other operations consist in the transplantation of muscles, as was done by Hoffa, who secured a good result by splitting up a portion of the insertion of the trapezius and implanting it into the deltoid muscle.

Recurrent Dislocation of the Shoulder.

By recurrent dislocation of the shoulder is meant a reproduction of a dislocation that is made possible by a structural change in the articulating surfaces or capsule of the joint, so that a force or movement which would

not cause the condition to occur in a normal joint is followed by the characteristic deformity. This is frequently seen in cases which have been treated an insufficient length of time to allow for natural repair.

The conditions present to cause this recurrence are: (1) A very large tear in the capsule. This is usually situated in the anterior or internal aspect. (2) A lax condition of the entire capsule may be present, or, instead of the insertion of the capsule at the inner margin of the joint, there may be free communication between the joint and the subscapular bursa. (3) There may be a partial fracture of the head of the humerus, so that a resulting osteochondritis dissecans takes place, causing a groove on the posterior surface of the head of the humerus. (4) A fracture may be present on the inner edge of the glenoid cavity, thus reducing the depth of the cavity. (5) Jöessel considered that in some instances the rotators or the great tuberosity were torn off, with the result that there was a marked lessening of the concentric stability of the articular surfaces during motion. (6) Burrell and Lovett consider that the atrophy and flabbiness of certain of the muscles of the affected side had considerable to do in the causation of the lesion. (7) Some cases are due undoubtedly to syringomyelia and Charcot's disease.

Symptoms.—Following the primary dislocation there may be a period of weeks or months without a recurrence taking place, until suddenly while the arm is in a certain position dislocation recurs. This may follow very slight exertion, and in some cases there is absolutely no trauma. The condition seems to occur simply by muscular action when the arm is held in certain positions favorable for the production of the dislocation. The displacement may be anterior or posterior. The greater majority are posterior. The dislocation may recur several times, and not again for a long period, or it may occur many times. As a result of the condition there is atrophy of muscles about the shoulder. Whether this is due to disuse or whether it is the cause of the condition has not been decided. There usually results moderate limitation of motion, which is not due to muscular action, but in all probability to changes in the joint structures, and to the formation of fringes, loose bodies, and exostoses.

Prognosis.—Without treatment it is rare for a complete cure to take place. With proper apparatus to limit abduction and elevation of the arm, recurrences can be prevented. The best results have been obtained by operation.

Treatment.—This may be divided into mechanical and operative. Re-

duction is usually accomplished with ease. When cases are first seen and there have been only a few recurrences, the lesion present is probably a loose capsule. This should be treated by massage, electricity, and passive motion. Movements—chiefly abduction and elevation—which generally cause the recurrence are to be prohibited.

The best apparatus is the one already described under Loose Shoulder-joint. In conjunction with the apparatus massage, electricity, and passive motion should be given. Attempts at cure have been made from time to time by the injection into the joint of iodoform emulsion and tincture of iodine, and while in several instances good results have been obtained, the utility of this method is questionable. In general, these latter methods have fallen into disuse, and it is now considered that operative treatment is the one most often followed by good results.

All the operations in vogue aim to restore the stability of the head of the humerus by narrowing of the capsule of the joint. This may be performed in several ways, differing from each other only in the method of treating the capsule. The arm being held in slight abduction, a vertical incision about 4 inches long is made on the anterior surface of the arm from the coracoid process to the insertion of the pectoralis major muscle. The latter is separated from the deltoid, exposing the subscapularis muscle. The subscapularis and the upper half of the insertion of the pectoralis major muscles are divided, exposing the capsule of the joint. It may be narrowed by taking out a triangular portion of the anterior wall of the capsule and suturing the edges with chromicized catgut; by a purse-string suture; by reefing the capsule with silkworm-gut; by incising the capsule longitudinally and overlapping the inner edge over the outer edge with silver wire sutures. If the joint is opened,—and in most cases it is advisable to do so,—all loose bodies, fringes, and pedunculated growths may be removed. The cut muscles and the skin are then sutured and the upper extremity immobilized for six to eight weeks, after which passive motion may be used. When the dislocation is posterior, an incision three inches long should be made along the posterior border of the deltoid, exposing the capsule, which should be sutured as in the foregoing description.

Obstetric Paralysis.

Obstetric paralysis is the term used to designate the partial or complete paralysis which is sometimes seen following prolonged labor or instrumental delivery. It may occasionally occur after normal labor. Traction made

upon the head in head presentation or upon the body in breech presentations is the exciting cause. It may also occur during extreme rotation of the head.

Pathology.—The pathologic lesions present may be a rupture of the two upper roots (fifth and sixth cervical) of the brachial plexus. Stone has shown that when traction is made upon the shoulder the upper two roots are made very tense and then rupture while the three lower roots remain lax. The muscles involved are usually the biceps, the deltoid, and the supinators of the forearm.

Symptoms.—The condition is present from birth. The attitude is characteristic, the arm being held slightly backward and slightly abducted, while the hand is extremely pronated and the fingers flexed. That the paralysis is not complete is shown by the movements possible in certain directions, and occasionally there is some motion in the flexors and extensors of the forearm. The shoulder itself is absolutely powerless. As time goes on, the extremity does not grow as rapidly as its fellow, so that when adult life is reached there may be several inches of shortening. If the condition goes untreated, the structures about the joint become markedly atrophied and relaxed so that the condition may in time simulate congenital subluxation.

Prognosis.—The prognosis in cases of complete paralysis that are not treated or do not improve rapidly within two to three months is very bad. In most cases recovery is only partial. There are restriction of most movements, atrophy of certain groups of muscles, and retardation in growth of the entire extremity.

Treatment.—This consists in absolute rest in the early cases until all swelling and tenderness have disappeared. The forearm should be supported in a sling, and if necessary a pad in the axilla to lessen the tendency to laxity of the capsule and subluxation. The entire extremity should be thoroughly massaged daily, the joints should be passively moved several times daily, and galvanic electricity applied to the affected muscles three times a week. If dislocation occurs as a result of neglectful or faulty treatment, it should be reduced and the tone of the muscles kept up as much as possible. If muscular contractures occur, they should be overcome by myotomy. Some good results may follow transplantation of tendons, especially in the forearm, so as to overcome the marked pronation and flexion.

Congenital Elevation of the Scapula.

Synonyms.—Sprengel's deformity; Angeborener Hochstand der Scapula; Surélévation congénitale de l'omoplate.

Congenital elevation of the scapula is a rather rare deformity. The condition consists of an abnormal elevation of the scapula above the level of its fellow. The deformity may be moderate and consist only of inward rotation of the lower angle of the scapula, or all the structures of the shoulder-joint may be elevated. Lateral curvature is present in nearly all cases, the concavity being on the side opposite the deformity. The normal motions of the scapula are limited and abduction in some cases is not possible beyond 100 degrees from the vertical line. In some cases there are other congenital deformities, as torticollis and asymmetry of the face. Wilson and Rugh report two cases in which the posterior border of the scapula was attached by a bony process to the spine of the seventh cervical vertebra, and Goldthwait and Painter report one case in which there was a direct articulation between the upper angle of the scapula and the vertebræ. Kölliker and Hoffa report four other cases in which the upper angle of the scapula was bent forward and had been diagnosed as exostoses. The upward displacement of the scapula varies from one-half to two and a half inches in patients under ten years; in those older it varies from one to four and a half inches. Males are affected more frequently than females, and cases of bilateral deformity are reported by Honsell, Wittfield, and Milo.

Pathology.—In some cases the affected scapula is smaller than its fellow (Goldthwait and Painter's case). There may be an attachment of the scapula to the vertebræ by an osseous band or there may be firm union. The muscles usually affected are the trapezius, the rhomboids, the levator anguli scapulæ, and the serratus magnus. Examination of these muscles shows a condition similar to that found in torticollis, or an almost entire absence of muscular tissue which has been replaced by fibrous tissue.

Statistics.—The condition was first described by Eulenberg in 1863, and received general attention when Sprengel, in 1891, reported four cases occurring in children from one to seven years. Pitsch in 1898 reported seventeen cases from the literature, and in 1900 Rager reported thirty-two cases. Cases have also been reported by Wilson and Rugh, Honsell, Wittfield, Milo, Goldthwait and Painter, Kölliker and Hoffa, and Spillissy.

Etiology.—Sprengel and others consider the condition to be due to a faulty position of the fetus from an insufficiency of amniotic fluid. He con-

sidered that the arm was held behind the back by pressure and that this deformity always recurred after birth as a result of the prolonged intra-uterine pressure. Kausch thought the condition was due to some defects in the lower part of the trapezius muscle. Chievitz thought that the deformity could be accounted for by the fact that the upper extremity arises as a cervical appendage and during early fetal life remains in an elevated position, and that any intra-uterine condition interfering with its proper descent might be the cause of the deformity. Kirmisson considered the condition to be due to an arrest of development of the scapula, as in some cases the affected scapula is smaller than its fellow. Cases of acquired elevation of the shoulder due to rachitis have been reported by K  lliker, Gross, and Bender.

Treatment.—When cases are seen early the treatment should consist in open division of the contracted muscles. If bony union exists between the scapula and the vertebr  e it should be removed. When the superior inner angle is bent markedly forward a portion may be removed if it interferes with reposition of the scapula. After union has taken place there is at times a tendency for slight recurrence, which should be prevented by massage and active and passive movements. There is often a tendency to increase of the scoliosis present if the condition remains untreated. In adults if the limitation of motion is only moderate and is not increasing, very little good will be obtained by operation. In patients who have been operated upon, there is usually considerable difficulty in holding the scapula in its normal position.

Congenital Absence of the Clavicle.

This is an extremely rare condition. The defect may be a complete absence of one or both clavicles, but there is usually a rudimentary portion near the sternum. This portion may vary from $\frac{1}{2}$ to 3 inches. The condition does not, as a rule, cause any functional disturbance, and its presence is discovered by accident. The cause is due to lack of development *in utero*. A characteristic feature of the condition is the ease with which the shoulders may be approximated. Most cases require no treatment. If any loss of function occurs, the shoulders may be strengthened by a suitable brace to hold them back into normal position.

Rupture of the Biceps Muscle.

Rupture of the biceps muscle is generally the result of too great a demand made upon it during contraction or to local disease. It is seen almost exclusively

in men whose work is very laborious, and while endeavoring to lift heavy weights suddenly produce a partial or complete tear of the muscle. It sometimes occurs when there is a general degenerative process of the muscular system, as in alcoholics, when there is a local degenerative process, as in fatty degeneration, or when the muscle has been the seat of a previous rupture or when it has been weakened by the removal of a tumor.

Statistics.—There were 18 cases of rupture of the biceps among 81 cases of general muscular rupture reported by Maydl. Sixty-six cases of rupture of the biceps are reported by Loos; of these, only two occurred in women. The seat of rupture in 56 of these cases was as follows: 49 of the long head; 2 of the short head; 1 of both heads; 3 of the distal tendon; and 3 of the common belly of the biceps. Of the 49 cases in which the seat of rupture was of the long head, 10 were in the upper tendon, 20 at the musculotendinous junction, and 17 in the belly of the muscle.

Symptoms.—At the time of the injury the patient feels a sharp pain and in some cases heard an audible snap at the seat of rupture. This is accompanied by partial or complete loss of power of flexion, especially when the forearm is in a position of supination. This occurs on account of the power of flexion which the brachialis anticus has when the forearm is pronated. Examination shows at the seat of rupture a deep groove, increasing on contraction, between the torn ends when efforts are made at flexion. The position of the rupture is shown by the approximation of the belly of the muscle on contraction toward the elbow if high up and vice versa. Considerable hemorrhage takes place at the seat of rupture, which is shown later by ecchymosis occurring usually on the inner side of the arm.

Diagnosis.—This depends upon the history, the sudden pain and snap, followed by the appearance of the groove between the two contracted ends of the muscle and inability to flex the elbow when the forearm is supinated.

Prognosis.—This depends upon the cause and the extent of the rupture. When the rupture occurs in normal muscular tissue and is only partial the prognosis without operation is good. When complete rupture occurs in normal muscle good function may follow non-operative treatment if the torn ends can be held in good apposition. As a rule, only fibrous union occurs, which in time may stretch or be the cause of a recurrence. In cases due to general or local disease the immediate prognosis with operation is good, but recurrence may take place; without operation, the functional results are poor.

Treatment.—Non-operative treatment consists in immobilizing the entire

extremity and by approximating the torn ends by means of bandages to lessen the circumference of the arm. This is upon the principle of stroking the ends together, which can be done when no contraction is present. If the separation is marked, especially in young subjects, operation is advisable. This consists in cutting down upon the muscles at the seat of rupture and suturing the ends together by chromicized catgut. The limb should then be immobilized until sufficient time has occurred for firm union to take place, when massage, electricity, and gradually passive and active motion may be instituted.

CHAPTER XII.

TUBERCULOUS DISEASE OF THE ELBOW-JOINT.

The elbow-joint is affected more frequently by tuberculosis than either the shoulder-joint or the wrist-joint and is fifth in order compared with other joints. Tuberculous disease of the elbow-joint is more frequent as a complication of tuberculosis of the viscera than the other joints.

Statistics.—In 2292 cases treated at the Orthopedic Department of the Hospital of the University of Pennsylvania the elbow-joint was involved in six instances. Whitman states that there were 56 cases of tuberculous elbow-joint disease in 1883 cases of joint disease treated at the Hospital for Ruptured and Crippled. Females are affected more frequently than males and the left more often than the right side. König gives the age as follows: 25 per cent. under ten years; between ten and twenty years, 20 per cent.; between twenty and thirty years, 12 per cent.; between thirty and forty years, 15 per cent.; between forty and fifty years, 8 per cent.; between fifty and sixty years, 14 per cent.; and between sixty and seventy years, 6 per cent. In 59 cases reported by Whitman 40 were under ten years.

The primary focus may be in the synovial membrane or in one of the bones forming the joint. In 137 cases Middeldorf found the disease primarily synovial in 30 and primarily osseous in 107. König found the disease primarily synovial in 29 per cent. and primarily osseous in 71 per cent. of 137 cases. The statistics of Scheimpflug give a very high percentage (92.8 per cent.) to the primarily osseous form.

In the osteal form the ulna more often contains the primary focus than the other bones. Middeldorf's statistics of 107 cases show the distribution as follows: Ulna, chiefly olecranon, 49; humerus, 33; external condyle, 4; humerus and ulna together, 18; radius, 3; all of the bones, 2; and radius and ulna together, 2. In the 81 cases reported by König the primary focus was situated as follows: humerus, 43; olecranon, 36; and radius, 2. Ollier observed in 119 cases that the olecranon was the seat of the primary focus in 73, the humerus in 33, and the radius in 12 cases.

Pathology.—The pathologic changes taking place in tuberculous elbow-

joint disease are identical with those of other joints. There is, however, a marked tendency toward suppuration and the formation of abscesses and sinuses. The capsule of the joint being rapidly destroyed, abscesses form around the joint and progress down the forearm, in the intermuscular septa. After a time the ligaments and



FIG. 362.—TUBERCULOUS DISEASE OF RADIUS AND ULNA, INVOLVING ELBOW-JOINT.

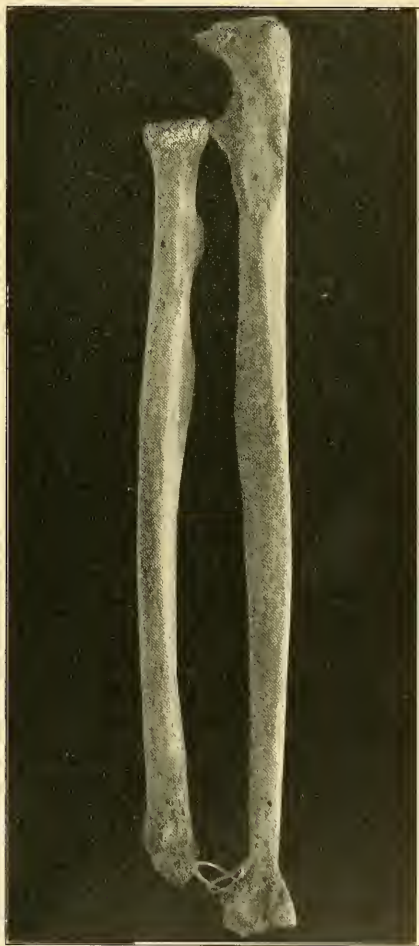


FIG. 363.—TUBERCULOUS ARTHRITIS OF ELBOW-JOINT SHOWING DISEASE OF RADIUS.

cartilages are destroyed, leaving a joint in which movements are possible in all directions.

Symptoms.—The usual phenomena of chronic joint disease—pain, swelling, tenderness, muscular spasm and atrophy, abscess and sinus formation—are present here as in other joints. There is perhaps no joint so frequently subject to tuberculous disease resulting from traumatism as the elbow-joint. The symptoms therefore may follow those resulting from injury. At first there may be slight swelling with obliteration of the bony outlines, moderate induration over the condyles or olecranon, and slight limitation of flexion and extension. The condition develops very slowly. The primary osseous foci may remain dormant for some time, and except for slight induration over the affected part and some feeling of weakness in the joint all symptoms may be absent until the primary focus ruptures into the joint or external to it, when there appears marked edema around the joint, which increases and is made quite evident by contrast with the atrophy of the muscles of the arm and forearm. This edema about the elbow, on account of its shape and characteristics, has been called the “spindle-shaped white swelling.” Before this takes place, however, there may occur marked synovitis as a result of primary infection of the synovial membrane or following rupture of an osseous foci into the joint. This swelling is noticeable by the protrusion of the capsule over the head of the radius anteriorly and posteriorly at either side of the triceps tendon; this effusion is soon marked by the swelling above mentioned.

Limitation of motion begins as soon as effusion takes place in the joint and increases with the progress of the disease and becomes marked as soon as joint motions become painful, until the characteristic deformity results, which generally is with the elbow a little more than 90 degrees and the forearm midway between pronation and supination.

Muscular spasm occurs early in the disease and is one of the causes of the limitation of motion. This varies at times and may be very great as the muscular effort to diminish certain starting pains causes an increase in the spasm and increased diminution of the range of flexion and extension.

Muscular atrophy is present early in the disease and varies with functional disability of the joint. It is in marked contrast to the swelling about the joint and serves to intensify the latter.

In elbow-joint disease there is a marked tendency to the occurrence of abscesses and fistulas. As a rule, these abscesses open nearest to the primary seat of the infection. If the condyles are primarily affected, the abscesses usually open just below the condyles; in the synovial form they open externally just below the condyle; when the olecranon is affected, they point usually

externally, or may rupture along the posterior surface of the forearm. The destructive process may be so extensive that the soft parts are riddled with sinuses, the synovial membrane, ligaments, and articular cartilages are destroyed, lateral mobility is present, so that the entire elbow is an edematous, bluish-gray, shapeless mass, in which the only chance to save the patient's life is by amputation.

Prognosis.—This depends considerably on the age, on the degree of involvement of the tubercular process, on the patient's general condition, and on the presence or absence of other tuberculous foci. If cases are seen early and in childhood, the prognosis for cure and a fair range of motion is good. These early cases in childhood do very well under conservative treatment, and while the duration of the disease is usually from two to three years, the joint recovers a good range of motion. There are doubtless many cases in childhood which recover without any special treatment. Cases that are seen in which the joint is involved to only a limited extent or those in which extension takes place extra-articularly, as sometimes occur when the primary focus is in the olecranon, generally recover with a more useful joint under mild operative measures than those of extensive involvement of the intra-articular and extra-articular structures. Patients who begin treatment before the general conditions is affected by the local process do much better than those in which the mixed infection has taken place, extensive involvement is present, and in whom very often there are evidence of amyloid degeneration of the viscera. This is also true of the presence or absence of tuberculous foci elsewhere.

The functional results are good, even though ankylosis takes place, provided the elbow-joint forms a right angle. In this position the function of the arm is but little impaired. If the disease occurs during childhood, there usually results more or less shortening.

Treatment.—Constitutional treatment is of the greatest importance and should be continued for a long period. A large number of cases retain normal motion when conservatively treated. This consists in immobilization, which in some cases may be supplemented by injections of iodoform, and passive congestion. The entire extremity should be immobilized in the position which, should ankylosis occur, will be the most useful. The position of election is at 90 degrees, with the hand midway between pronation and supination. Attempts should be made to attain this position as soon as the patient begins treatment, and it should be maintained until all active inflammation has ceased. This position may be maintained by means of slings and splints made of wood,

tin, plaster-of-Paris, and leather. Of all apparatus for keeping the parts at rest, preference is given to splints made of plaster-of-Paris or molded leather. These splints afford protection as well as fixation, can be used until the parts decrease in size, and are readily replaced. The sling is a very efficient means of securing immobilization, but should always be supplemented by a swathe including the chest and arm. When the elbow is not in a favorable position, should ankylosis occur, the position which is caused by muscular spasm may be corrected by the application of a plaster-of-Paris bandage applied from the hand to the axilla; making no attempt to correct the deformity. On removing this bandage at the end of several weeks it will be found that most of the muscular spasm has disappeared, so that a good functional position can be obtained without undue force and another plaster-of-Paris bandage applied. The same result may be obtained by a sling supporting the wrist. The hand should be carried upward to the neck as far as muscular fixation at the elbow will allow, the head should be carried forward, and the limb supported by a sling passed around the neck and wrist. After several days the head will be erect, and this procedure may be repeated until the position of the elbow is good for function if ankylosis should occur. If ankylosis is present when the case is first seen and the position is very poor for functional use, the latter may be corrected by elastic force after the method of Weigel.

Injections of iodoform emulsion are of value, and may be used as supplementary to fixation. When the capsule becomes very tense, it may be aspirated and refilled by an emulsion of iodoform (10 per cent.). The technic of injection here is the same as that of other joints. The most accessible points for inserting the needle are just behind the head of the radius, at the side of the olecranon, or beneath the internal condyle. When abscesses have formed, they may be aspirated and treated in the same way. Fistulas may be filled with the emulsion and the openings tamponed. All writers agree on the value of iodoform in treating tuberculous joint disease, especially in children, in whom more radical treatment would be followed by disturbances in growth. Bier's method of passive congestion has some advocates who use it in some cases as an aid to iodoform injections.

If after a thorough trial of conservative measures no improvement is manifest and the disease progresses, more energetic measures should not be delayed. They consist in cureting osseous foci, arthrectomy, partial and complete resection, and amputation.

Small fistulas and osseous foci should be thoroughly cureted, sequestra

removed, and attempts made to secure primary union. When the disease is limited to the synovial membrane, arthroctomy may be performed through any of the incisions used for resection. All granulation tissue, the capsule and cartilaginous disks should be carefully removed with scissors. If small areas of diseased bone are present, they may be excised by a chisel.

The indications for resection are similar to those of other joints. When the condition is progressively becoming worse under conservative treatment, and especially in adults, operative treatment is indicated, and while the results of excision, particularly in the elbow-joint, are not so good as those of more conservative measures, yet if the condition is allowed to continue there soon comes a time when amputation will offer the only means of saving the patient's life. The joint may be opened by the posterior incision inside of the median



FIG. 364.—ELBOW-JOINT DISEASE AFTER ERASION.

line, extending about $2\frac{1}{2}$ inches above and below the olecranon. The incision is carried down to the bone, the periosteum and soft parts above it lifted up from the bone by an elevator. Care should be taken to preserve the integrity of the muscles, and particularly the lateral ligaments. The articular surfaces of the involved bones may then be dislocated and resected by means of a saw and chisels. Partial resection is always preferable to complete resection in all cases, particularly if the operation is performed during childhood. The portions excised should always be limited to the part involved.

So many modifications of the typical resection are possible that no attempt can be made to give any set rules to be followed. The after-treatment consists in thorough fixation and protection. This is best obtained in a plaster-of-Paris splint which can be removed if necessary. In most cases ankylosis is desired,

so that fixation may be continued an indefinite time and the muscular tone may be improved by massage and electricity. If the muscles and ligaments are well preserved and only a partial resection was performed, passive motion may be instituted early in the hope of obtaining a certain degree of motion. Resection is also indicated for faulty position in order to give an arm that functionally will be better than one ankylosed in a position that entirely unfits it for use.

The indications for amputation are the same as those of other joints, and while it is rarely necessary, yet when extensive destruction of the capsule, ligaments, and cartilages takes place, the soft parts are riddled with sinuses, and the patient's general condition is steadily becoming worse, amputation is urgently demanded.

Statistics on Resection.—Culbertson records 290 cases of tuberculous wrist-joint disease which recovered after resection had been performed. Of these, the joint was perfect in 32 and useful in 196 instances. The statistics from Kocher's clinic of 40 cases treated by resection were reported by Oeschman. Of these 40 cases, 15 were dead, the cause being tuberculosis in 8 cases, other causes in 2, and unknown in 5 instances. Of these 15 patients, 11 lived from five to twenty years. No patients died as a result of the operation. There was complete cure in 96 per cent. of cases. In 64 per cent. of these the patients were able to use the arm for hard work and in 36 per cent. they were capable of only light work. In 59 per cent. of the cases that had a complete cure the movements of the elbow-joint were normal, in 11 per cent. ankylosis was present, in 15 per cent. there was subluxation, and in 12 per cent. there was a loose joint. The statistics of König on resection are as follows: In those on whom complete resection was performed 54 per cent. had complete recovery; in 8 per cent. the recovery was incomplete; and 38 per cent. died. In those on whom partial resection was performed there was complete recovery in 32 per cent.; incomplete recovery in 8 per cent.; and 61 per cent. died. The functional results given by the same writer were as follows: there were 60 per cent. of recoveries with moderate motion and good power, 33 per cent. had ankylosis and fair power, and in seven per cent. there was a resulting loose joint. These results were obtained in 45 cases, in which he used Langenbeck's operation in 40 and his own in 5 instances.

CHAPTER XIII.

NON-TUBERCULOUS DISEASES OF THE ELBOW-JOINT.

Free Bodies in the Elbow-joint.

While free bodies are not found so frequently in the elbow-joint as in the knee-joint, yet their presence is rather frequent and gives rise to considerable inconvenience and impairment of the joint. They may be entirely free in the joint or may be attached by periosteum. The latter form is often seen in fractures of the head of the radius. Their most frequent position is near the head of the radius, in the coronoid fossa, and in the olecranon fossa.

Etiology.—Free bodies may be due to fracture, as is seen in the chisel-fractures of the head of the radius. They are sometimes due to avulsion. Most authorities, including König, hold that traumatism is but a minor etiologic factor in the production of free bodies. They claim that the condition results from an erosion of the cartilage or pathologic changes in the bone, so that a very trifling injury is sufficient to separate the diseased portion from the bone forming a free body. M. Wilms considers that the majority of free bodies are due to an injury occurring years previously. Martens considers them to be due to a pathologic change which he calls “osteochondritis dissecans.” The free bodies usually consist of cartilage, but rarely may consist of bone.

Symptoms.—The onset varies according to the cause. Usually there may be symptoms referred to the joint following injury, or the symptoms may develop gradually. Pain and localized tenderness are usually present. The capsule may be distended by a synovitis. At times the loose body may be palpated. The most characteristic symptom is limitation of flexion and extension. This depends upon the position of the body; when it is present in the coronoid fossa, there may be moderate limitation of flexion, and when in the olecranon fossa extension may be limited 10 to 25 degrees. Occasionally pronation and supination may be interfered with if the body is near the head of the radius or attached to it by periosteum. Crepitus is usually present. At times there may be excessive callus formation at the seat of the chipping off of the portion forming the free body.

Diagnosis.—This depends upon the history, the presence of a movable

body which is palpable, limitation of motion, and the results of an *x-ray* examination.

Treatment.—When the symptoms are undoubtedly those of a free body and its presence can be demonstrated by the *x-ray* photograph, the removal of the free body is indicated. The incision necessary will vary with the position of the body. If in the olecranon fossa, a posterior incision will readily expose it. If in the coronoid fossa or near the head of the radius, an anterior incision followed by careful dissection to expose the capsule will be necessary. Care should be taken not to injure any of the structures in the cubital space. After removal of the free body the joint usually regains its normal range of motion and is entirely free from all further symptoms.

Cubitus Varus and Valgus.

Cubitus varus and valgus may be defined as those conditions in which the axis of the forearm when fully extended deviates more or less than normal from the longitudinal axis of the arm; cubitus varus being an adduction angle and cubitus valgus an abduction angle as compared with the normal. There is a physiologic cubitus valgus present in all people, and commonly known as the "carrying angle." This angle may be accentuated, and varies normally in males from 1 to 9 degrees and in females from 15 to 25 degrees; so that the angle formed by the longitudinal axis of the arm and forearm, which physiologically in men is 173 degrees and in women is 167 degrees, may vary within the above limits. This physiologic increase in the angle, according to the investigations of Hübscher, takes place after puberty, and is not caused by changes in the joint itself, but occurs as a result of outward deviation of the lower end of the diaphysis of the humerus. The greater increase in females may be accounted for by the fact of the relative narrowness of the shoulders compared with that of the pelvis, and the necessity for this increase so as to render a useful "carrying arm." A congenital increase of the normal angle may be due to laxity of the articular ligaments which allow of hyperextension. M. Wilms considers that cubitus valgus and varus may occur during post-natal growth as a result of premature ossification of one or the other of the upper epiphyses of the ulna or radius, thereby creating an inequality in length of the bones of the forearm, which in turn causes the abnormal position of the forearm.

The condition is sometimes seen in early childhood, as a manifestation of rachitis, and while it may persist for a long time, in most cases it disappears soon after all weight is taken off the arm.

Cubitus valgus and varus may be due to fracture of either condyle of the humerus, to injury to the lower epiphyseal line of the humerus, and to rupture of the lateral ligaments of the elbow. The deformity resulting in traumatic cubitus varus is commonly called a "gunstock deformity."

Treatment.—The mild forms of cubitus varus and valgus do not require any treatment. Severe cases due to deviation of the lower end of the humerus may be corrected by a cuneiform osteotomy of the shaft of the humerus. Cases which are due to inequality of growth of the radius and ulna may be corrected after puberty by removing a suitable section from the longer of the two bones. When the deformity follows a fracture of either condyle of the humerus the position should be corrected before union has taken place, and if the case is not seen until after union is firm, an osteotomy will usually overcome the deformity.

Olecranon Bursitis.

Synonym.—Miner's elbow.

Inflammation of the olecranon bursa may be due to an acute chronic or suppurative process. The acute condition is found following traumatism and localized septic wounds in the region of the elbow. Chronic inflammation is due to an occupation in which the tip of the elbow is subject to repeated trauma, as in miners; hence the synonym. Suppurative processes take place as a result of punctured or lacerated wounds.

The **symptoms** of acute and chronic bursitis are those of bursæ elsewhere. The olecranon bursa is fairly large and is situated over the tip of the olecranon process. In acute inflammation there is the presence of an elastic, fluctuating, non-tender swelling in the region of the bursa. In the chronic form there is added a sense of considerable thickness to the walls, and at times there may be felt small, irregular, fibrinous bodies. In the suppurative variety there are added to the acute form local heat, tenderness, redness and edema of the surrounding soft parts, acute noditis of the axillary lymph-nodes, and perhaps some increase in the general temperature.

In the acute form **treatment** consists in placing the limb at rest and exerting pressure on the bursa by means of an elastic bandage or similar means. In chronic olecranon bursitis the bursa should be dissected from the surrounding structures and removed or incised, its cavity thoroughly curetted, and the wound closed in the hope of obtaining primary union. In suppurative olecranon bursitis the treatment consists in incision, curetment, and drainage.

CHAPTER XIV.

TUBERCULOUS DISEASE OF THE WRIST-JOINT.

Tuberculous inflammation of the wrist-joint is a rare affection occurring about as frequently as chronic shoulder-joint disease. It is rarely seen in children, but occurs usually in adults. Ridlon states that children with syphilitic antecedents are at times subject to tuberculous disease of the wrist-joint. Very often in adults there is the history of a sprain or some other mild injury which did not at the time cause the patient any inconvenience. Tuberculous disease of the wrist-joint is usually accompanied by phthisis, or it may be a local manifestation of miliary tuberculosis. It rarely continues any length of time without the development of phthisis, and in most cases the two affections are well advanced when first seen.

Statistics.—In 5680 cases of orthopedic disease treated in the Orthopedic Department of the Hospital of the University of Pennsylvania, there were 10 cases of tuberculous wrist-joint disease. In 919 cases of tuberculous joint disease collected by Cheyne from the statistics of Jaffé, Schmalfuss, Billroth, Menzel, and his own records, the wrist and hand were affected in 6 instances. Whitman states that in 3105 cases treated in the out-patient department of the Hospital for Ruptured and Crippled during five years there were 4 cases of wrist-joint disease. Karewski states that in 990 cases of joint disease occurring during childhood the wrist-joint was involved in 31 instances. Of 43 cases treated by excision by Ollier there were none under thirteen years of age.

Pathology.—The pathologic changes which take place at the wrist-joint are similar to those of other joints. On account of the extensive arrangement of the synovial membrane all parts become finally involved. As a rule, the sheaths of the tendons become secondarily involved, greatly complicate the disease, and add materially to the gravity of the prognosis. It should not be forgotten that the tendon-sheath may become primarily involved and closely resemble disease of the wrist-joint. The disease may be primarily synovial or osseous. Cheyne says that the former type prevails at this joint, but in most cases the primary focus is difficult to find. Moore states that in all the cases

which he has operated upon the primary focus was osseous. In the osseous form the primary focus may be in the radius, carpal bones, or metacarpals. The symptoms and course are greatly dependent upon the origin of the disease. Beginning in the radius, it may be manifested by a diffuse involvement of the shaft beyond the epiphyseal line, as a cone-shaped focus in the epiphysis, or it may be situated under the cartilage. When the disease begins in the carpus, it may be localized to one bone, but in most cases several bones with the synovial membrane are early involved. When the bases of the metacarpal bones are primarily involved, it is usual for the disease to be localized and extend into the shaft rather than extend into the joint.

Symptoms.—The first symptoms to attract notice are swelling and tenderness about the joint. Muscular spasm and pain, which are so frequently present in tuberculous disease of other joints, are not prominent here in the early stages. The swelling is dependent upon the degree of involvement of the joint structures. When it is localized to one bone, the swelling is generally circumscribed. If all the joint structures are involved, the swelling surrounds the entire joint, is more marked on the dorsal surface, and when the tendon-sheaths become involved extends up and down the forearm. If the swell-



FIG. 365.—WRIST-JOINT DISEASE (Ashhurst).

ing becomes very diffuse and the muscular atrophy marked, there is generally present the characteristic spindle-shaped "white swelling." Muscular atrophy, limitation of motion, and flexion deformity are usually well marked. Accompanying the flexion deformity, the fingers become straight and the thumb extended alongside the index-finger. The joint surfaces become exceedingly sensitive to pressure. Suppuration occurs in many cases in adults, but is rare in children. Fistulas form usually at the sides of the extensor tendons, and in a large majority of cases finally involve the tendon-sheaths. At the site of the fistulas there generally develops secondary inoculation of the skin with the development of lupus for an extensive area about the fistula. Pulmonary tuberculosis is generally present either when the case is first seen or develops later.

Diagnosis.—This depends upon the history, the presence of tuberculous disease elsewhere, and symptoms of increasing functional disability, tenderness, limitation of motion, swelling, muscular atrophy, suppuration, and extension of infection with the formation of cutaneous tuberculosis. A diagnosis is more difficult when the tuberculous process involves only one or two bones of the car-

pus, but all doubt will be ended by the results of an x-ray examination. The condition is to be distinguished from a tenosynovitis and gonorrheal arthritis at the wrist-joint.

Prognosis.—The prognosis of tuberculous wrist-joint disease is always grave on account of the presence of an existing tuberculous condition elsewhere, as phthisis, or by reason of the tendency of secondary infection to occur with disease of the wrist-joint. Nearly all cases of tuberculous wrist-joint disease die of pulmonary tuberculosis. In children, however, the prognosis is better, as the percentage of coexisting phthisis is not so great; yet very few live to maturity. When extensive involvement of the tendon-sheaths takes place and extensive suppuration occurs, the only means of prolonging life is by amputation, and even then the prognosis is very bad.

Treatment.—The treatment depends upon the extent of the disease, the age, and the general condition. In no condition is radical surgery more justified than in tuberculous wrist-joint disease in the adult. In childhood suppuration, if it occurs, is usually circumscribed, and conservative methods give good results. The general health should be improved by tonics, outdoor air, and plenty of sunlight. Conservative treatment consists in fixation in a plaster-of-Paris bandage from the metacarpophalangeal joint to the elbow, combined with a sling to support the hand and forearm. If flexion deformity is present, it may be gradually corrected by the successive use of plaster-of-Paris bandages applied without any undue effort being made to correct the deformity. After removing each bandage at the end of two weeks, the muscular spasm will have decreased to such an extent as to allow partial corrections every time. As ankylosis is the most favorable result to be expected, the wrist should be placed in a position of moderate dorsal flexion, this being the best position for use. Bier's method of passive congestion may be followed by favorable results in some cases. Injections of iodoform emulsion (10 per cent.) are often of value. The needle can be inserted just below the styloid of the radius and ulna to either side of the extensor tendons. Its use is contraindicated by the presence of sequestra. It is followed by excellent results in the treatment of cold abscesses. When the foci are limited to one bone, as the epiphysis of the radius or the head of a metacarpal, the disease may be arrested by curetment or partial arthrectomy. When suppuration and fistulas are present in the adult, radical means are indicated, on account of the danger of pulmonary tuberculosis.

Of operative measures, excision and amputation only should be considered, as arthrectomy is almost impossible on account of the anatomic structure of the

joint. Excision is to be recommended when the general health is good and when the disease is not very extensive. The method of Lister is the one most frequently used. It consists of a dorsal and radial incision. It should be rendered bloodless by employing an Esmarch bandage. All the diseased structures, including the articulating end of the radius, all the carpal and heads of the metacarpal bones. The wound may then be dusted with iodoform powder and closed, hoping to obtain primary union. After a sterile dressing has been applied a plaster-of-Paris bandage extending from the fingers to the elbow should be applied. No attempt should be made to secure a movable joint. Studsgaard, of Copenhagen, recommends a complete splitting of the hand for tuberculous wrist-joint disease. The incision is made between the third and fourth metacarpal bones, and is continued upward between the os magnum and unciform and between the semilunar and cuneiform bones. Both the superficial and deep palmar arches are cut and ligated. This method allows of very free access to the carpus and has been successfully used in this country by Mynter.

When the tendon-sheaths are extensively involved, the general condition is poor, and the disease is progressing rapidly, amputation is followed by better results, and affords more relief than resection. Amputation should always be performed when pulmonary tuberculosis is present, when the patient is subject to considerable suffering and is generally debilitated. While the prognosis is very poor even with amputation, the patients are made more comfortable for the short time they have to live and the pulmonary condition often shows signs of improvement.

Statistics on Resection.—Ollier reports 17 cases of excision of the wrist-joint for tuberculous disease in which the results were excellent; in none was subsequent amputation required. Gross states that his mortality was 11.7 per cent. for excisions and 12.8 per cent. for amputations. Bradford and Lovett state that in a series of 79 cases in which excision was performed, in 8 per cent. the results were perfect, in 46 per cent. useful limbs were secured, and in 24 per cent. the results were worthless. This list includes partial and complete excision.

Tuberculous Disease of the Metacarpals and Phalanges.

Synonym.—*Spina ventosa*.

By *spina ventosa* is meant a tuberculous disease of the metacarpals and phalanges affecting the epiphyseal end of the shaft and rapidly involving the entire medullary substance and destroying the spongy and cortical bone. The latter is

constantly being replaced by a peripheral external growth from the periosteum, so that in time the bone becomes very much increased in circumference, spindle-shaped, and its cavity is filled with boggy granulation tissue in which are fragments of sequestered bone. The process may continue until the entire bone is destroyed, or a stage of repair may take place, a sinus form, the sequestra be gradually discharged, and in time the parts may return to normal. The disease may occur in only one bone, but is generally seen as a multiple lesion occurring in several bones of the same or fellow joints. It is a disease occurring usually during childhood, and the metacarpal bones are more often affected.

Symptoms.—The local symptoms are those of swelling, pain, and tenderness. At first the swelling is localized, but later may become more diffuse, so that the function of the tendons is interfered with. The condition when involving the metacarpals may be mistaken for tenosynovitis. The picture of spina ventosa involving the phalanges is very characteristic and can hardly be confused with any other condition except syphilitic dactylitis.

Treatment.—When there are no signs of suppuration, the treatment consists in immobilization of the part by means of a splint extending from the tip of the fingers to the elbow or by a plaster-of-Paris bandage. If suppuration occurs, the abscess should be opened and only as much of the diseased bone as will separate readily should be removed. The cavity should then be drained. Care should be taken to avoid wounding the tendon-sheaths. When the disease involves the phalanges, it may be necessary to perform an amputation on account of the deformity and disturbances in growth which often follow spina ventosa.

CHAPTER XV.

NON-TUBERCULOUS DISEASES OF THE WRIST-JOINT.

Tenosynovitis.

Anatomy.—The bursæ about the wrist-joint are similar in character to those found about the ankle-joint. Nearly all of them consist of sheaths formed by reflections of synovial-like membrane from the fibrous sheath of the tendon on to the tendon itself. Those on the flexor surface cross the wrist beneath the anterior annular ligament and are the following: (1) One for the flexor longus pollicis, which extends almost to the insertion of this tendon. (2) A bursa for the tendons of the flexor sublimis digitorum, which are divided into four parts. (3) A large bursa for the tendons of the flexor profundus digitorum, which usually connects with that for the sublimis tendons. The sheaths of these tendons are prolonged along the tendons to the index, middle, and ring fingers only to about the middle of the palm of the hand, but continue along the tendons of the fifth finger. The bursa usually connects with the sheath of the flexor longus pollicis, and together they are known as the great carpal bursa. The synovial sheaths of the tendons to the index, middle, and ring fingers extend from the heads of the metacarpal bones to the middle of the distal phalanges and do not communicate with the great carpal bursa. (4) There is a small round bursa connected with the flexor carpi ulnaris and separating it from the internal lateral ligament.

The tendons on the extensor surface of the wrist pass beneath the posterior annular ligament through six compartments. Each of these compartments has a synovial lining which extends well above and below the annular ligament. From within outward they contain the following tendons: ⁽¹⁾ the extensor carpi ulnaris, ⁽²⁾ the extensor minimi digiti, ⁽³⁾ the extensor communis, ⁽⁴⁾ the extensor indices, ⁽⁵⁾ the extensor secundi internodii pollicis, the extensor ⁽⁶⁾ carpi radialis longior and brevior, the extensor primi internodii pollicis, and the extensor ossis metacarpi pollicis.

The sheaths and their inclosed tendons about the wrist-joint may be subject to acute, chronic, or tuberculous inflammation. As an acute condition it usually results from injury or excessive use, or it may be due to gonorrhea. It is frequently seen in carpenters, washwomen, and locksmiths. It generally affects

the sheaths of the extensor tendons, particularly those of the thumb. Chronic tenosynovitis may result from repeated acute attacks or may be due to gonorrhea and infectious diseases. Tuberculous inflammation very frequently attacks the tendon-sheaths and may be the only manifestation of the disease. Purulent inflammation may involve the tendon-sheaths and carpal bursa and cause extensive destruction of the sheaths and tendons with resulting deformity and disability of the hand.

Pathology.—In the acute cases there is marked congestion of the walls of the sheaths, accompanied by an excessive outpouring of serum and fibrin. As the former becomes absorbed the latter forms adhesions between the two layers of the sac, causing the fine crepitation which is so characteristic of the condition. In the chronic non-tuberculous form there is marked thickening of the walls of the sheath, adhesions occur between the apposed surfaces, and in places there may be calcareous deposits. Tuberculosis may be present in any of the three following forms: (1) as a serous effusion; (2) with "rice bodies"; (3) in the fungous variety. In the latter form there is complete destruction of the tendon-sheaths, the cavity being filled with necrotic tissue and pus.

In the purulent variety affecting the flexor tendon-sheaths infection is self-limited when it involves the sheaths of the index, middle, and ring fingers; but when it involves the bursæ of the thumb and little finger, it rapidly spreads throughout the great carpal bursa and extends up the forearm and causes early and rapid destruction of all the flexor sheaths.

Symptoms.—In the acute variety there is pain on voluntary extension or flexion, with moderate swelling of the sheaths affected, combined with crepitation and moderate tenderness. In the chronic and tuberculous varieties there is marked swelling along the region of the tendon-sheaths affected. When this is marked and involves the great carpal bursæ, there is considerable bulging above and below the anterior annular ligament, which resembles an hour-glass in shape. It is possible in some cases to detect the presence of rice bodies. In the purulent form if the thumb or fifth finger is the seat of the original infection there may be progressive increase in size of the part involved with a similar condition noticeable below the wrist and later extending above the wrist. There is also marked lymphangitis, enlargement of the epitrochlear and axillary lymph-nodes, and constitutional symptoms of infection. The resulting deformity following suppurative tenosynovitis is very bad. When the wounds finally heal, the fingers and thumb and wrist are markedly flexed, motion is limited to slight flexion and extension, muscular atrophy is usually well marked, and the

soft parts especially of the hand are swollen, reddish-blue, cold, and often contain sinuses surrounded by sluggish granulation tissue. The end-result of such a condition is a hand that is practically useless for any kind of work.

Diagnosis.—The diagnosis depends upon the swelling, localized to the region of the tendon-sheaths; the crepitus, which is present only on voluntary muscular effort; the moderate tenderness; the presence of "rice bodies," felt on palpation in the tubercular cases; and by the history of excessive muscular action or of an acute infection.

The condition may be confused with tuberculous wrist-joint disease. It is differentiated from the latter by the fact that the swelling is not so evenly distributed to the region of the joint, but is generally confined to one or more tendon-sheaths and extends along the course of the involved tendons up and down the forearm and hand. Muscular atrophy is not so marked. The tenderness is present on direct pressure and is not produced by pressing the joint surfaces together. Deformity, if present, is entirely different from that of tuberculous wrist-joint disease, and any limitation of motion present is not due to changes in the joint.

Treatment.—The treatment of the acute form of tenosynovitis consists in immobilization on an anterior or posterior wood splint extending from the fingertips to the elbow. This should be supplemented by large doses of sodium salicylate, which seems to act favorably in this condition. Rest of the part may also be obtained by means of adhesive plaster strapping so applied as to cause compression and to prevent motion of the involved tendon-sheaths. After five to seven days' immobilization all symptoms will have disappeared. Occasionally in the acute form due to gonorrhea pain, tenderness, and swelling may be so great as to require aspiration of the inflammatory exudate. The part should then be immobilized for two to three weeks, when massage, baking, and passive motion should be instituted.

The chronic form of tenosynovitis at times yields to prolonged baking with hot air, massage, and passive motion, but most cases require incision and the injection of some astringent solution, as nitrate of silver (1 per cent. solution), followed by compression, or the entire sheath may be removed.

Tuberculous tenosynovitis requires very persistent treatment. As a rule, the condition tends to progress from a serous variety to the form in which "rice bodies" are found, and then to complete destruction of the entire sheath. Injections of iodoform emulsion (10 per cent.) have been followed in the serous form by very good results. When "rice bodies" are present, the sheaths may

be opened and attempts made to wash out the "bodies" by salt solution, after which astringent injections may be used, followed by compression. This may be followed by complete cure, but most cases in which there are "rice bodies" and those where the entire sheaths are destroyed require complete extirpation of the sheaths.

Purulent tenosynovitis calls for early and radical incisions. If the great carpal bursa is not involved, which may be predetermined by the finger in which the infection begins, a single incision or perhaps two incisions will afford sufficient drainage. If, however, the great carpal bursa is involved and the swelling and fluctuation extend up the forearm under the anterior annular ligament, the only hope of obtaining a useful hand lies in making multiple incisions below and above the annular ligament and establishing free drainage until the wounds are entirely healed. The resulting deformity mentioned above should be treated by massage, baking with hot air, passive and active motion. In some cases the destructive process in some of the fingers may be so great as to necessitate amputation.

Ganglion.

Ganglion is the term applied to a smooth, fluctuating, usually spheric and occasionally lobulated tumor, situated upon the dorsum of the wrist. Ganglia are generally separated from the joint by a thin septa and are nearly always attached to one or more tendon-sheaths. They are fairly movable under the skin and vary in size from that of a pea to that of a large walnut. They occur generally in youth, are more common in females, and may at times involve both wrists and ankles at the same time.

Etiology.—Various theories based upon personal investigations have been advanced from time to time to account for the formation of ganglia. Gosselin, Teichmann, and v. Volkmann regarded ganglia as retention cysts formed by the protrusion of diverticula from the synovial membrane of the joint, which after a time become entirely separated from the latter by adhesive inflammation taking place within the pedicle and the conversion of the synovial fluid into a thick gelatinous material. Other authorities, including Virchow, Riedel, and Ledderhose, maintain that certain forms of ganglia—colloid cysts—are formed by the coalescence of a number of small cysts which have their origin from the spaces in the cellular tissue about the tendon-sheaths. It is often shown in dissecting out ganglia from the surrounding structures that on cutting the pedicle there generally occurs an escape of synovial fluid, and this fact of itself shows

the intimate relation of the ganglia with the joint cavity. It is considered by most authorities that the adhesions between the ganglia and tendon-sheaths is secondary.

Symptoms.—The subjective symptoms of ganglia are generally *nil*. Their presence rarely ever causes any functional disturbance. Objectively there is noticed an increasing, painless, fluctuating tumor, occurring generally on the posterior aspect of the wrist-joint. They are more frequent on the radial side, and may present between any of the tendons. König states that they occasionally produce discomfort and functional disturbance in pianists when present near the radial styloid on the posterior aspect of the wrist.

Treatment.—The treatment may be classed under three heads: (1) conservative means; (2) methods to cause obliteration of the sac; and (3) extirpation.

By conservative means attempts are made to rupture the sac and to cause obliteration by the slight inflammatory reaction which may occur. This crushing may be performed by forcible crushing with the thumb, a heavy book, or a hammer. After this is done a pad with a solid back is placed over the former swelling and constant pressure is produced. Under this method of treatment the ganglion is liable to recur.

The methods used to cause obliteration of the sac are: (1) aspiration followed by the injection of tincture of iodine or nitrate of silver (1 per cent. solution); (2) subcutaneous discission with a tenotome; (3) the introduction of a catgut suture through the ganglion, allowing the fluid to escape and leaving the suture in place for several days; and (4) splitting the ganglion and packing the cavity with gauze, allowing it to heal by granulation. While the sac is often obliterated by these means, there is always the danger of infection occurring and producing a secondary suppurative arthritis or tenosynovitis.

Extirpation offers the only positive means of preventing recurrence. Thorough aseptic precautions should be used. If possible, the sac should be dissected from the surrounding structures without being opened, and the wound closed, expecting primary union to take place. A pressure bandage and an anterior splint from the fingers to the elbow should be applied outside the sterile dressing. In seven to ten days the wound will be healed and everything except a small protective dressing of sterile gauze may be removed.

Sprain of the Wrist.

Under the indefinite term of sprain are included all injuries about the wrist-joint caused by indirect violence which, however, is not sufficiently forcible to cause a fracture or dislocation. The condition is caused most frequently by falls upon the hand or by forced rotary movements.

The anatomic lesion may be a slight tear of the synovial membrane, tears and stretching of ligaments, displacement or tears of tendons, and fracture of cartilages or avulsion of small fragments of bone. Very often fractures of the lower end of the radius, especially those entering the joint, are mistaken for sprains.

Symptoms of Acute Sprain.—Following the injury, rapid swelling takes place, which may be due only to an effusion into the wrist-joint; or when the tendons and their sheaths are involved, the swelling is not confined to the joint, but occurs also as a result of effusion into the tendon-sheaths. Pain is present from the beginning, and is increased by motion. Tenderness is generally localized to the points of local injury and is often a means of determining accurately the nature and seat of the sprain.

Chronic Sprain.—The symptoms of chronic sprain are generally prolonged weakness and disability at the wrist-joint. Many cases are due to the prolonged immobilization following an acute sprain, while others are due to a fracture of the lower end of the radius. There is persistent swelling, usually slight abduction deformity, and limitation of motion due to involvement of the tendon-sheaths.

Diagnosis.—This depends upon the history of induced violence, the nature of the swelling, the localization of tenderness. In all severe cases or in those in which swelling is marked or deformity is present an x-ray examination should be made to exclude fractures.

Treatment.—Acute sprains of moderate severity should be treated by the application of adhesive plaster in strips extending from the metacarpophalangeal joint to the upper third of the forearm. While this form of dressing does not entirely mobilize the parts, yet in most cases it gives sufficient support and at the same time allows moderate motion, which materially hastens the absorption of the effusion. If compression and immobilization are desired, they may be obtained by the use of pasteboard strip splints molded to the part, and any degree of compression may be obtained. It is rarely necessary to apply a wood or plaster-of-Paris splint. After all swelling and tenderness have disappeared

restoration to normal function will be hastened by massage, hot air, and passive and active motion.

Chronic sprains should never be immobilized. Very often an x -ray examination will reveal a fracture which may necessitate an osteotomy for proper reduction. If no fracture is present, the condition should be treated by massage, hot and cold douches, counter-irritants, hot air, and passive and active motion.

CHAPTER XVI.

NON-TUBERCULOUS JOINT DISEASES.

While many of the affections belonging in this category have been described under the individual joints most frequently affected, there remain certain infectious and malignant diseases which, on account of their importance or general distribution, deserve special consideration. These include osteomyelitis, the various forms of non-tuberculous arthritis, and certain constitutional conditions affecting the articulations.

Trauma as an Etiologic Factor in Joint Diseases.

The popular idea among the laity that all joint disease is due to traumatism is well illustrated by the number of patients who come to clinics, claiming that the onset of the joint disease for which they desire treatment dates back to some previous injury. This is true not only in the cases of tuberculous arthritis, but also in cases of non-tuberculous joint disease. This popular idea is strongly supported by clinical observation and statistical evidence. That various joint lesions are localized by a previous trauma of moderate degree is also shown by experiments on animals which are supplemented by our observations in the human being. Foci of disease generally are localized near joints which have received a previous slight injury, and do not follow, as a rule, when severe injury, as a fracture, has occurred. They usually follow injuries of moderate severity, as sprains and contusions. The course ascribed in the formation of a suitable field for the setting up of a focus of disease by injuries of moderate severity is that the inflammatory reaction following the trauma is favorable to development of a localized process, while the process is so active following severe injuries that the infecting agent is generally destroyed. In acute osteomyelitis in children there is usually a history of trauma. If patients suffering from gonorrheal urethritis receive a moderate injury to a joint, the probability of a gonorrheal arthritis developing is very great. Van Hansel records cases of patients suffering from syphilis who developed syphilitic periosteitis and gumma following traumatism.

Synovitis.

Synovitis is the term applied to an inflammatory process of the joint in which the synovial membrane alone is involved. No permanent pathologic process is produced. When other joint structures become involved in the condition and permanent changes are liable to take place, the term applied to such a condition is arthritis.

Three forms of synovitis are recognized:

1. Acute serous synovitis.
2. Chronic serous synovitis.
3. Intermittent joint hydrops.

Acute Serous Synovitis.

Etiology.—Acute serous synovitis is usually the result of direct or indirect violence to a joint, and is seen most frequently following sprains, fractures, dislocations, and contusions. It may be the result of a punctured wound of the joint or of a gunshot wound from a modern rifle bullet or a sterile foreign body. It sometimes is seen in the early stages of multiple gonorrheal arthritis before the infection is localized in one joint; it occurs in rheumatism and in some of the infectious fevers, as scarlet and typhoid fevers. It may be a symptom of urethral fever, and occasionally is seen in connection with a localized septic process near the joint, as in carbuncle, septic wounds of the soft parts, and erysipelas.

Pathology.—Acute serous synovitis begins as a hyperemia of the synovial membrane, stasis of the blood-current occurs, dilatation of the capillaries, and serous exudate containing a small number of leukocytes and some fibrin. If due to traumatism, there may be hemorrhage in varying degrees, producing a yellowish-red or red color in the effusion. The synovial membrane and villi are swollen and in areas may show localized ecchymoses. In this stage under proper treatment the fluid will become absorbed and the joint surfaces return to their normal condition.

Symptoms.—Following one of the causes enumerated above, there is marked change in contour of the joint surfaces due to the effusion. The normal furrows are obliterated. Fluctuation is present and in the knee-joint there is floating up of the patella and ballottement. The joint is slightly flexed, or in whatever position allows of the greater distention of the capsule of the joint. The skin is normal in color, tense, and there may be slight increase in local temperature. Pain and tenderness on pressure may be present

in varying degrees. There is moderate disability and some loss of function present.

Diagnosis.—This depends upon the history, the sudden onset, the absence of fever, and the local signs of increased fluid within the joint.

Treatment.—The treatment of acute serous synovitis must be both constitutional and local. A saline purge, preceded in some cases by a mild dose of calomel, may be followed by the administration of nitrate of potash, salicylate of soda, iodid of potash, or colchicum, according to the origin of the affection.

Locally, rest, either upon a pillow, in a plaster-of-Paris bandage, or on a suitable splint, and usually flying blisters, tincture of iodine applied over the joint, pressure, and moist heat, will be attended by the best results. When the fluid is absorbed, massage, hot and cold douches, hot air, passive and active motion, will soon return the parts to a normal condition. Moderate support, as given by a flannel or elastic bandage or an adhesive plaster dressing, should be used for some time.



FIG. 366.—FIMBRIATED GROWTHS OF THE SYNOVIAL MEMBRANE.

Chronic Serous Synovitis.

Etiology.—Chronic serous synovitis is usually the result of an improperly treated acute form; it may be due to repeated acute attacks, to some internal derangement of a joint, to a chronic epiphysitis, as is seen in the beginning stages of a tuberculous joint lesion, or to some extra-articular condition which interferes with

the normal functions of the joint, as is seen in ruptured ligaments and tendons.

Pathology.—In addition to the pathologic changes which take place in acute serous synovitis, there occurs moderate thickening of the synovial membrane, hypertrophy of the villi, and an increased amount of fibrin in the effusion. The latter is deposited upon the synovial membrane and cartilages, and later when it organizes may produce adhesions. The effusion is usually flocculent in character and may contain portions of detached villi. Exfoliation of the cartilage may occur.

Symptoms.—In addition to the acute symptoms, there is marked thickening of the periarticular structure; the swelling may vary in amount at various

times. Pain is generally absent. No interference with the joint functions occurs in the early stages, but later laxity of the structure results until moderate disability is present. A peculiar leathery crepitation due to fibrinous deposits is often present.

Treatment.—General medication has little influence upon the condition. Massage, hot and cold douches, and hot air may have some effect upon the effusion. Rest in a suitable splint, combined with pressure followed by the use of an elastic bandage, will in most cases result in ultimate cure. When the condition is due to some internal derangement of the joint structure or a tuberculous epiphysitis, the treatment of the cause of the effusion will usually be followed by a cure. The irrigation of the joint with carbolic acid solution (2 per cent.), repeated if necessary, followed by pressure and rest, not infrequently causes a cure. Injections of an emulsion of iodoform (10 per cent.) may be used with gratifying results. Injection of tincture of iodine is not advised on account of the strong reaction which usually follows and of the questionable results obtained.

Intermittent Joint Hydrops.

This is a rare form of serous synovitis usually involving the knee-joint. Other joints may be involved at the same time. The condition consists of swelling due to effusion or extra-articular edema. It may or may not follow traumatism. The peculiarity of the condition is its periodic recurrence at regular intervals of eleven to thirteen days or some other regular period. The attack continues for three to four days, after which the parts resume their normal condition and the joint functions are unimpaired. The affection is observed in men most commonly between thirty and forty years, and in women between twenty and thirty years. The affection is about equally distributed between the two sexes.

The condition may be divided into two classes: (1) symptomatic and (2) idiopathic.

Symptomatic Intermittent Joint Hydrops.—In this class the synovitis is secondary to some other condition. It has been observed most frequently in the following conditions: (1) acute splenic tumor; (2) malaria fever; (3) osteomyelitis; (4) gonorrhea; (5) autointoxication; (6) uric-acid diathesis; and (7) syphilis and tuberculosis.

Idiopathic Intermittent Joint Hydrops.—This form of the disease is usually associated with some disease of the nervous system, and is considered by Schlesinger to be a form of neurosis similar to angioneurotic edema. It has

been observed to occur in association with the following conditions: (1) menstruation; (2) epilepsy; (3) hysteria; (4) exophthalmic goiter; (5) progressive general paralysis; (6) nervous diarrhea; (7) pseudo-croup; (8) progressive asthma; and (9) it is closely related to the acute circumscribed edema of Quinke.

Schlesinger reported fifty-five cases of intermittent joint hydrops. Of these, forty-one were of the idiopathic variety. Of these fifty-five cases, the location of the disease is noted in forty-nine cases. The following table (Blood-good) shows his classification:

MALES.				
	IDIOPATHIC.	SYMPTOMS.	TOTAL.	PER CENT.
Up to 10 years of age, ...	0	0	0	0
" 20 " "	4	1	5	26
" 30 " "	3	2	5	26
" 40 " "	5	2	7	37
" 50 " "	1	1	2	11
" 60 " "	0	0	0	0
Not given, ...	4	1	5	26
			24	
FEMALES.				
	IDIOPATHIC.	SYMPTOMS.	TOTAL.	PER CENT.
Up to 10 years of age, ...	1	0	1	4
" 20 " "	7	1	8	33
" 30 " "	10	1	11	46
" 40 " "	2	1	3	13
" 50 " "	0	0	0	0
" 60 " "	1	0	1	4
Not given, ...	1	0	1	
			25	

Symptoms.—There is either a history of some condition near the affected joint producing a secondary synovitis or the condition is associated with some nervous lesion. The onset is sudden; the condition lasts for several days and disappears suddenly. It appears again at regular and irregular intervals. Locally there is swelling of the affected joint which may be due to effusion or extra-articular edema. There is no evidence of local inflammation or increased surface temperature. There may be associated with the condition swelling of the skin of the thigh or face. The condition disappears in several days, leaving the joint normal. If the acute attacks are frequent, slight swelling may continually be present.

Diagnosis.—This rests upon the associated history, the sudden onset of a painless, non-inflammatory swelling lasting several days, which disappears suddenly and is not followed by any permanent joint changes.

Treatment.—The treatment of the symptomatic form consists in treating the cause of the effusion. In the idiopathic variety favorable results have not always followed the most careful treatment. Arsenic may be used to advantage. Locally during the attack the conservative treatment consists in rest, ice, heat, and compression. If marked tension is produced, it may be relieved by aspiration. Arthrotomy and irrigation are never justifiable. After aspiration the reaccumulation may in some degree be prevented by compression. In some cases the disease disappears suddenly and does not recur.

—Infectious Osteomyelitis.

Infectious osteomyelitis is an acute suppurative inflammation of the shafts and epiphyses of the bone, the result of infection of the medulla by pyogenic germs. The process is essentially similar to furuncle of the soft parts, hence the pseudonym "bone furunculosis." The involvement of the epiphysis secondarily, or in rare instances primarily, with extension into the joint makes this disease interesting to the orthopedic surgeon.

Etiology.—The most frequent cause of infection is *Staphylococcus pyogenes aureus*, although the *Streptococcus pyogenes*, the pneumococcus, and typhoid bacteria are sometimes found. The bones most frequently attacked are the femur, tibia, and humerus. Infectious osteomyelitis is therefore not a specific disease, but one which may be produced by a variety of pyogenic micro-organisms or by a combination of these.

The disease is most common in early life or childhood, being an involvement of bones which have not been completely developed, but it is occasionally met in advanced life. Boys are affected three times as frequently as girls. As predisposing causes exposure to wet and cold, injuries to the bones, and compound fractures may be cited, and the condition may also be a sequella of some infectious disease, as typhoid fever, scarlet fever, smallpox, measles, or pneumonia. Or it may be secondary to affections of other parts, as paronychia, furuncle, or chronic ulcer.

Pathology.—The pathology of this affection has been carefully recorded by Nichols, Lannelongue, Lexer, and others. The primary infection is always in the medulla, the disease beginning usually in the shaft of the long bones, very rarely in the epiphysis. The cortex and bony trabeculae are secondarily destroyed. The process is active and abscesses quickly appear. Necrosis occurs, and in the later stages the solution and destruction of the bone tissue is very extensive. The inflammatory process extends beneath the periosteum,

forming a subperiosteal abscess, the periosteum is stripped from the bone, and the infection spreads to the surrounding structures, producing myositis and necrosis. When the disease originates primarily in the epiphysis, or extends secondarily to it, the bone cavity soon becomes involved from extension, and synovitis, simple or purulent, results. The epiphyseal line may be destroyed, and separation of the epiphysis, or spontaneous fracture, may result.

Symptoms.—The onset is sudden, with local throbbing pain. Motion is not at first interfered with, but the bone is sensitive upon pressure. Swelling is marked over the area of infection and the part pits upon pressure. The temperature rises and the pulse is accelerated. The tongue is dry and the face flushed and anxious. Leukocytosis is present. Abscesses form in the superficial structures and their rupture or release by incision is followed by sinuses.

Diagnosis.—This disease must be distinguished from acute articular rheumatism, arthritis deformans syphilitica, tuberculosis of the joints, and typhoid fever.

It can readily be distinguished from articular rheumatism by the fact that it affects only a single joint, and by the rapidity with which it develops, together with the grave symptoms which accompany it, and particularly by the occurrence of suppuration. From gonorrheal rheumatism the differential diagnosis is more difficult, since this lesion is often monarticular, but the previous history of the individual and the absence of suppuration would be of value in distinguishing the affection. In arthritis deformans syphilitica when the disease is acute the resemblance to acute osteomyelitis is very strong, especially if suppuration occurs. The presence of lesions in other parts of the body, the deformity of the shaft of the bone from bending, and the localized character of the periosteitis in this disease would render the diagnosis less difficult. Tuberculosis of the joints would resemble osteomyelitis if the latter disease began in the epiphysis, but the rapid course of the disease, the absence of tuberculous diathesis, and the acute and grave character of the symptoms would serve to differentiate the two affections. Osteomyelitis should also be distinguished from typhoid fever. In this instance the severe character of the local symptoms, the high leukocytosis, and the failure to detect the Widal reaction would render the diagnosis sufficiently clear.

Prognosis.—In the severe forms of osteomyelitis the prognosis is very grave, and it will depend upon the early and radical measures undertaken to prevent the spread of the infection. It is frequently followed by separation of the epiphysis, and ankylosis is not uncommon when joint involvement occurs.

Treatment.—The treatment consists in early incision and drainage of the infected area. The incision should be free and the cortex of the bone should be trephined. Curettage of the deep structures is not recommended by Nichols, since it interferes with bone regeneration.

The acute symptoms will be abated by the incision and drainage, and subsequently, usually in about eight weeks, the necrotic bone will require removal. The time for this operation should be carefully determined, and should be during the stage when marked ossification has begun in the deeper layers of the periosteum, but is not far advanced. The best operation will be found to be that of Nichols. This consists in exposing the necrotic area through a long incision, stripping the periosteum from the necrotic shaft, care being taken not to puncture the periosteum but to retain it as a periosteal tube in as perfect condition as possible. The necrotic shaft is removed with lion-jawed forceps, section by means of a saw sometimes being necessary. The infiltrated area is disinfected with 95 per cent. carbolic acid for two or three minutes and is neutralized with alcohol. The periosteum is then folded in and approximated with sutures. The hemorrhage is severe and may be controlled by an Esmarch bandage, or the operation may be divided into two or more stages. Since the operation cannot be perfectly aseptic, drainage should be established. Considerable reaction follows the operation.

Joint involvement should be treated in the same manner as acute septic arthritis, which will be found in another section. The deformities following infectious osteomyelitis should be treated the same as those which follow tuberculous joint disease.

Traumatic Arthritis.

Under the term traumatic arthritis should be classified those changes in the joint structures which occur without a fracture or dislocation taking place. These changes are so many and at first so often not recognized that in time they may lead to permanent disability. The classification of these lesions as given by Bloodgood is as follows: (a) An exudate with or without hemorrhage; this may take place into the joint cavity alone (an effusion) or into the tissue without the synovial membrane; (b) rupture of the capsule of the joint; (c) rupture of one or more auxiliary ligaments; (d) complete or incomplete dislocation or tear of the intra-articular cartilage (as the semilunar of the knee-joint); (e) complete or incomplete separation of the articular cartilage; (f) slight incomplete fissured fractures of the articular

ends of the bone; (g) tear-fractures of small bony prominences near the joint, with or without their dislocation between the joint surfaces.

Pathology.—Following the injury there occurs considerable stretching and in most cases tearing of the synovial membrane and ligaments about the joint, this being accompanied by marked effusion, which may be limited to the joint cavity, but generally involves the extra-articular structures as well and contains varying amounts of hemorrhage. When this effusion is limited to the intra-articular structures, it is readily recognized by the characteristic signs of joint effusion, and when it invades the extra-articular structures it is characterized by edema of the surrounding structures. Examination of the synovial membrane shows marked edema with the surface glossy, in which may be numerous areas of ecchymoses, and in places the surface of the membrane and the effusion contain fibrin.

Symptoms.—As a result of the injury there follow a number of symptoms which, if careful attention is paid, will materially aid in the recognition of the condition. A marked effusion takes place which is readily recognized by the obliteration of the normal contour of the joint surfaces, by the fluctuation, and by the position assumed to allow for the complete distention of the capsule. This is shown at the knee by flexion, at the hip by abduction, flexion, and outward rotation. This effusion is soon masked by the extra-articular edema which rapidly takes place. Hemorrhage taking place into the effusion is shown by superficial ecchymosis within forty-eight hours, and is generally a sign of rather severe injury. Marked tenderness will be present over the site of the lesion, and very often it may be possible to recognize a rupture of the joint capsule, surrounding ligaments, and tendons by increased joint mobility or by the presence of an abnormal depression. An example of the increased mobility is shown in rupture of the lateral ligaments of the elbow-joint or knee-joint. As the exudate is absorbed distinct depressions may persist, and the diagnosis may be made on this symptom alone, as is seen in partial or complete rupture of the tendon of the quadriceps femoris or in the lateral expansions of this tendon. Persistent local tenderness at the epiphysis generally means an intra-articular fracture or the tearing off of a small spicule of bone. In cases that do not recover rapidly under appropriate treatment or when not treated there is persistent disability and weakness of the joint structures.

Diagnosis.—The recognition of the condition depends upon the history of trauma which did not cause an evident fracture or dislocation, the local

signs of intra-articular and extra-articular exudate, the local tenderness, increased mobility, the detection of a depression or pit on palpation, the persistent joint weakness, and the negative results of the x-ray photograph.

Treatment.—If the effusion is slight and the lesion is evidently mild, immediate application of a pressure bandage will limit an increase in the exudate. This also gives the part a rest and assists the circulation to reabsorb in the exudate. If the effusion is excessive, aspiration of the joint is indicated not only to relieve the acute local symptoms which often attend the condition, but it also relieves the distended capsule of considerable pressure, prevents overdistention, and at the same time affords an opportunity for a bacteriologic examination of the exudate. If the fluid reaccumulates, repeated aspiration may be used; and if the examination of the exudate shows a pyogenic infection, early arthrotomy, irrigation, and drainage will give, in most cases, a useful joint.

After the acute symptoms have subsided, in addition to rest and a pressure bandage, hot air and massage once or twice daily will materially aid in a return of the joint structures to normal. After one week, in mild cases, the patient should be given passive motion and encouraged to use the part. When pain and loss of function persist, it is evident that a more severe condition exists, such as a lacerated joint capsule or tendon, an injury of the cartilage, or an intra-articular fracture. In these cases the relaxation of the tendons and joint structures requires prolonged support in some suitable apparatus. This support, however, should be vigorously supplemented by hot air, massage, hot and cold douches, and passive motion.

Suppurative Arthritis.

Suppurative arthritis varies in its intensity and in the extent of involvement of surrounding structures according to the infecting agent. Certain micro-organisms cause rapid and complete destruction of the intra-articular and extra-articular structures, and in many cases terminates in death, while other micro-organisms may cause only moderate intra-articular changes and in some cases are only followed by ankylosis. The most frequent causes of suppurative arthritis are: (1) penetrating wounds entering the joint or just external to its capsule; (2) direct extension from a focus of acute suppurative osteomyelitis; (3) extension through the blood from a diseased focus elsewhere in the body; (4) as one of many lesions of pyemia; (5) extension by the lymphatic system from an infected wound at some distance from the joint; (6) direct extension from an infected wound near the joint.

Pathology.—The changes which take place in suppurative arthritis are in most cases rapid. As a rule, when the infecting agent is a pyogenic organism, in the first few hours the condition consists of some effusion which is serous or sero-fibrinous. At the same time the synovial membrane will show the presence of the infecting organism surrounded by the products of inflammation. The effusion rapidly becomes purulent, contains many leukocytes in all stages of degeneration, and in some cases a slight amount of blood. Numerous organisms can be demonstrated throughout the fluid and synovial membrane. The latter becomes edematous and rapidly undergoes various stages of degeneration. The inflammation may be confined to the intra-articular structures and subsynovial tissues, with consequent marked peri-articular edema, or extension may take place, rupture of the synovial membrane may occur, and the inflammatory process may attack the cartilages, bones, tendons, bursæ, and muscles about the joint, and abscesses result which in turn cause extensive destruction to all the soft parts.

When the arthritis is secondary to an acute suppurative osteomyelitis, the joint symptoms often mask the bone inflammation, and the latter condition is very often not recognized. The infecting organisms most frequently found in suppurative arthritis are the streptococcus, the *Staphylococcus albus* and *aureus*, the pneumococcus, the typhoid bacillus, the *Bacillus aerogenes capsulatus*, and the gonococcus.

Suppurative arthritis following pneumonia is very rare. While there is frequently noted a joint effusion as a sequel to pneumonia, it is in most instances sterile. While some cases have been reported as occurring independently of pneumonia, it is doubted very much whether a careful inquiry would not have established a history of pneumonia. Most cases in which the joint is infected by the pneumococcus are the subject of a general septicemia. Herrick gives the mortality as 65 per cent., based upon a study of fifty-two reported cases. In most cases the infection is polyarticular. The arthritis is often seen in association with a pneumococcus meningitis.

Suppurative arthritis following typhoid fever is at times rather severe, while in other instances the infection seems to be mild. The arthritis may be a primary infection, but in most cases is due to a neighboring focus in the epiphysis. This form of purulent arthritis may not be virulent, or the joint may recover after conservative treatment, while at times it may be very extensive and destructive and lead to spontaneous dislocations, as shown by Keen's series of 84 cases, in which spontaneous dislocation occurred in 40 per cent. of the

cases. Whitman reports a case in which there was destructive arthritis of one hip-joint, spontaneous displacement of the femur on the other side, and secondary contractures of the knee-joint and ankle-joint.

Symptoms.—The onset of the suppurative arthritis may be sudden or gradual, according to the infecting agent. The symptoms may come on after recovering from an attack of pneumonia, typhoid fever, or other acute infectious disease. At first there may be a chill, followed by fever, which continues high; the local joint symptoms may be those of a simple synovitis for twenty-four to forty-eight hours. After this time, as the swelling increases, there is marked redness, peri-articular edema, local tenderness, muscular spasm, deformity, lymphangitis, and adenitis. The temperature at first is continually elevated, but after a time it may drop to normal in the morning and be elevated in the evening. Constitutional symptoms of infection may occur, while the local inflammatory signs, unless relieved by operation, steadily progress until retrograde changes take place, rupture occurs, or death results from septicemia.

Diagnosis.—This depends upon the history of an acute infectious disease, trauma, a local septic process, or some primary focus of infection, combined with the local signs of suppuration, the general constitutional disturbance, the high leukocytosis, and the results of an examination of the effusion obtained by aspiration.

Treatment.—If in doubt as to the character of the effusion, better functional results will be obtained, convalescence shortened, the mortality decreased, and the secondary deformities prevented by thorough, efficient, operative treatment dependent upon the results of an examination of the aspirated fluid. If the fluid is found to be sterile, the treatment should be conservative. This should consist of rest and immobilization for a few days, and later these should be supplemented by massage, evaporating lotions, the application of heat and cold, and the institution of passive motion. Later, efforts should be made to prevent any deformity by means of appropriate apparatus.

When the aspirated fluid is found to contain pyogenic organisms, the affected joint should be thoroughly opened, irrigated, and efficient drainage established. If the infection is a mild one, drainage should be obtained by a strip of protective or rubber dam, as drainage-tubes and gauze are liable to increase the inflammatory condition of the synovial membrane. The arthrotomy may be performed under local anesthesia when the pneumococcus is the infecting agent, on account of the effect a general anesthetic would have upon the convalescent lung. If the infection is a severe one, general anesthesia should

be used, the incisions should be large, and it is often well to obtain postural drainage through the popliteal space. In many cases the arthritis is secondary to a bony focus. This is especially true in cases of acute epiphysitis in children, in typhoid infection, and occasionally in pneumococcus infection. It is extremely rare in gonorrheal infection. When operating, the bones entering into the formation of the joint should be carefully explored and any focus present should be thoroughly excised. When extra-articular abscesses form, they require multiple incisions for drainage. In some cases the general condition may be so bad and the infection so severe that amputation will offer the only means of saving the patient's life. The treatment of the deformities which are apt to occur as a result of the arthritis will be discussed under contractures and ankylosis.

Acute Suppurative Arthritis of Infancy.

Very often there is seen in infants an acute suppurative arthritis which is due to an extension of an acute epiphysitis involving the joint. In many cases the source of infection is not apparent, it often occurring without any other demonstrable focus. It may follow the acute exanthemata, and in some cases is due to a gonococcus infection. In most cases, however, the infecting agent is the *Staphylococcus aureus* or *albus* and the *streptococcus*. It may be a non-articular or a polyarticular infection, the former being more frequent. The hip-joint and the knee-joint are most frequently affected.

Symptoms.—The onset in most cases is gradual. The patient begins to complain of lameness and pain on motion at the affected joint. This is followed by localized swelling, at first limited to the epiphysis, but later involving the entire joint. The appearance of the joint resembles very much tuberculous disease except that there is more severe pain, some redness of the skin, marked tenderness, and greater constitutional disturbance. The course of the disease is more rapid than tuberculous disease. In a few cases the onset is sudden, the course rapid, and marked constitutional disturbances are present. If the process is allowed to continue, the entire joint may become disorganized, the epiphyses destroyed, subluxations occur, and peri-articular abscesses result.

Diagnosis.—This depends upon the rapidity of the joint symptoms, the marked constitutional disturbances, the leukocytosis, and the results of examination of the aspirated fluid.

Treatment.—As in all forms of supposed suppurative arthritis, early incision is indicated. If the effusion contains pyogenic organisms, the joint

should be thoroughly opened, osseous foci excised, the joint thoroughly irrigated and efficiently drained. During the course of treatment suitable apparatus should be used, not only to hold the parts at rest, but to prevent subluxations and ankylosis in a deformed position. In some cases the disease may have extended to the shaft of the bone, in which case it is advisable to remove the diseased epiphysis.

The Ultimate Results of Acute Suppurative Arthritis in Infancy.—In most cases the disease has extended so far and the epiphysis is so far diseased or destroyed that marked deformity results in after-life. In involvement of the hip-joint the destructive process is so extensive in some cases that the result in after-life resembles congenital dislocation. Hoffmann gives a mortality rate of 46 per cent., based on a study of 122 cases.

Syphilitic Joint Disease.

The recognition of chronic joint lesions as a manifestation of hereditary and acquired syphilitic infection is becoming more frequent, especially as the exact joint lesions of various diseases are becoming better understood. Previous to the discovery of the part played by the tubercle bacilli in chronic joint diseases many cases that were undoubtedly tubercular were looked upon as being due to syphilis. Since Koch's discovery, however, the comparatively infrequent diagnosis of syphilitic joint disease leads one to believe that errors were made in the other extreme and many cases were classified as tuberculous which could possibly have been traced to hereditary or acquired syphilis. Some surgeons went so far as to claim that there was no such lesion as syphilitic joint disease, as Ridlon states, commenting on the criticism given his paper on "Syphilitic Joint-disease in Children," which was read in 1886 before the Section on Orthopedic Surgery of the New York Academy of Medicine. Since then the subject has received considerable attention and the recognition of syphilitic joint lesions is very common.

Etiology.—Syphilitic joint disease may be due to inherited or acquired syphilis. Inherited syphilis may be transmitted from one or both parents, and in some cases may be transmitted from a grandparent, the parents having shown no evidence of the disease.

Inherited syphilis. Syphilitic joint disease affects the knee-joint more frequently than other joints; in many cases there is multiple epiphyseal involvement and the affection may be bilateral. It is more frequently complicated by arthritic symptoms than the acquired form. Güterbock considers that

joint lesions occur in one case in three hundred of inherited syphilis under five years of age. There may be two forms of inherited syphilitic joint disease: (1) the early variety, in which the lesion essentially involves the epiphyseal cartilage, known as the *osteochondritis* of Parrot; and (2) the late variety, in which the periosteum is chiefly involved, termed *osteoperiosteitis*.

Pathology.—Hereditary syphilis: The form seen in early childhood, and known as osteochondritis, is characterized by alterations occurring at the junction of the epiphysis with the diaphysis of the long bones. A longitudinal section made through these parts shows the line of junction as a bluish-white or yellowish-white irregular zone about 2 or 3 mm. in thickness. As the condition advances this line becomes thicker and more yellow. The microscopic changes consist in an irregular proliferation of the cartilage cells, premature calcification, a poor blood-supply and consequent fatty degeneration. As this necrosis occurs the area is surrounded by inflammatory tissue which is partly the cause of the increased thickness. As this necrosis continues suppuration may occur, and as a final result complete separation of the epiphysis may take place, so that future growth is prevented. The neighboring joint is sooner or later the seat of an arthritis which may be serous or purulent. Some cases are characterized by ultimate destruction of the cartilage.

In the late form of hereditary syphilis there occurs an osteoperiosteitis in the bones near the joint. It is characterized by a gummatous, infiltrating overgrowth of the epiphysis, which produces a spindle-shaped swelling and resembles in some degree the tumor albus of tuberculous knee-joint disease. The knee is the usual seat of the disease. The joint is generally involved, there being an increased amount of fluid in the joints with marked hypertrophy of the synovial membrane. Several joints may be affected simultaneously.

Acquired syphilis: The pathologic changes in syphilitic joints may occur in two forms: a primary infection of the synovial membrane, and a secondary infection due to the extension of an osteomyelitis. When primary infection takes place, there results hypertrophy of the synovial membrane, and marked enlargement of the villi occurs. Gummatous formation may be single or multiple. Necrosis and resultant disorganization of the intra-articular structures or suppuration never takes place. Fibrous ankylosis is liable to occur on account of the inflammatory changes caused by the gummata, and the resulting scar formation which takes place in healing under treatment. When the arthritis is secondary to an osteomyelitis, hypertrophy of the synovial membrane and villi occurs, and gummatous formation may be single or multiple, or may

be pedunculated and form intra-articular free bodies. Marked disorganization of the cartilage may occur, which process begins in the center and extends to the periphery. The gummata are firm, reddish-gray, and irregular in character.

Gummatous formation in the shaft of the bones appears as an osteo-periosteitis, and is characterized by the formation of a smooth, fluctuating swelling beneath the periosteum. The spongy structure of the bone may also be the seat of gummata. The fluid is cloudy and contains but very few cells. Later fatty degeneration and absorption take place with the formation of scar tissue and permanent thickening of the bone.

Symptoms.—In hereditary syphilis there is marked enlargement of one or several epiphyses, generally followed by involvement of the joint. Moderate muscular spasm and atrophy may occur. The subjective symptoms are slight. In the convalescent stage limitation of motion or complete ankylosis may result. There are generally other signs of hereditary syphilis present. In some cases there may be violent symptoms suggesting suppurative arthritis.

In acquired syphilis the onset of the arthritis is rarely acute, and generally occurs in the secondary stage of the disease. Syphilitic involvement of a joint is sometimes seen in the tertiary stage. The knee is the usual joint affected. It may be bilateral or other joints may be involved with the knee. The physical signs are concomitant with the syphilitic rash, and consist of severe pain, tenderness, and gradual swelling at the involved joint. The pain is generally more intense at night. There may be a tendency to contraction in either flexion or abduction. The affection is very rarely acute, except when suppuration occurs. Functional disturbance is usually very slight.

Diagnosis.—There is generally in the hereditary form, and always in the acquired form, a history of syphilitic infection or signs of the disease elsewhere. In the hereditary form the disease appears either in the first few months or as a late form from the fifteenth to the eighteenth year. The epiphyseal enlargements are generally painless and are distinguished from those of rachitis by their irregular distribution, by the age of the patient, and by the presence of other syphilitic symptoms.

The acquired form is recognized by the history of syphilitic infection, other signs of the disease, by its appearance about the time of the appearance of the rash, by the marked tenderness, and by the pain, which is greater at night. The condition may be confused with tuberculous joint disease, especially if only one joint is involved. In the latter there may be a history of syphilitic infection, which makes the diagnosis more difficult. A negative tuberculin test would

favor the diagnosis of syphilis. In syphilitic joint disease marked improvement takes place under specific treatment. In cases of extreme doubt, and where an absolute diagnosis is required, an arthrotomy may be performed and a portion of the synovial membrane removed for histologic study and animal inoculation.

Treatment.—In both hereditary and acquired syphilitic joint infection the treatment consists in attention to the general health, food, and medicinal measures. Specific treatment should be instituted in both forms of the disease. In the hereditary form mercury and potassium iodid may be used. Sublimite baths (8 grains to the bath) may be given to small children, as recommended by Güterbock. Calomel may be used in varying doses. If the stomach will tolerate large doses, children may be given one-thirtieth to one-twenty-fourth of a grain of bichlorid or biniodid, with from five to forty grains of potassium iodid three to four times a day, as recommended by Ridlon. Local treatment should not be neglected. In the acquired form the arthritic symptoms generally disappear at the time of the disappearance of the rash. If the joint symptoms occur in the secondary stage of the disease, mercury in any of its various forms may be used. When they occur in the tertiary stage and the gummata are large, in conjunction with medicinal treatment arthrotomy and total excision of the gummata will be followed by better results than if medicinal treatment alone is used. Mechanical measures and rest in bed are essential in some stages of the disease. Rest in bed is necessary during the painful stages of the acquired form. Occasionally mechanical apparatus may be used to advantage to give support to tender and painful joints and to prevent deformity, which in a small proportion of cases is liable to occur.

Gonorrheal Arthritis.

Gonorrheal infection of joints complicating cases of gonorrheal urethritis generally occurs during the late stage of an acute attack. It rarely occurs before the third week; it may occur during a very chronic attack and may complicate either a gonorrheal urethritis or follow ophthalmia neonatorum, as shown by the cases reviewed by Hawthorne. Moderate injury to some joint occurring during the late stage of gonorrhea is usually the predisposing cause to the development of gonorrheal arthritis.

Frequency and Order of Involvement.—Gonorrheal arthritis frequently begins as a polyarticular affection. The statistics of Markheim and those of Bloodgood showed that it was polyarticular in 56 and 60 per cent. of cases. Bloodgood, however, states that on admission to the hospital more than one

joint was affected in only 11 per cent. of cases. In a series of 251 cases reported by Northrup, 56 were monarticular, in 20 cases two joints were involved, and in 175 cases three or more joints. Mühsam found 30 monarticular infections in 41 cases. Julien found 143 monarticular infections in 348 cases. Markheim reports 52 cases in which the affection was mon-articular in 13, two joints were involved in 12, and in the other cases three or more joints were involved.

Markheim gives the following order of frequency of involvement: knee, hip, shoulder, wrist, and elbow. Bloodgood gives the order as follows: Knee, ankle, wrist, elbow, shoulder, and hip.

The combined statistics of Northrup, Finger, and Bennecke, comprising 704 cases, show that the joints were involved in the following order of frequency:

	NORTHROP.	FINGER.	BENNECKE.	TOTAL		NORTHROP.	FINGER.	BENNECKE.	TOTAL.
Knee, ...	91	136	31	258	Temporo-maxillary,	2	14		16
Ankle, ...	57	59	9	125	Small Joints of Foot,	40		6	46
Wrist, ...	27	43	6	76	Heel and Toes, ...	21			21
Elbow, ..	18	25	10	53	Small Joints of Hand,	11	35	4	50
Shoulder,	16	24	4	44	Sterno-clavicular, ...	3			3
Hip, ...	16	18	8	42	Other Articulations, .		21		21

Men are more frequently subject to gonorrheal arthritis than women, and about 3 to 5 per cent. of all cases of gonorrheal urethritis are complicated by joint lesions.

Pathology.—The joint lesions of gonorrheal infection may be classified under the following forms:

1. **Intra-articular inflammation.** This form consists of an acute inflammatory process which involves only the superficial layers of the synovial membrane, in which the effusion may be serous, sero-fibrinous, hemorrhagic, or purulent.

2. **Extra-articular inflammation.** This form is characterized by a marked inflammatory process occurring in the peri-articular structures. The joint infection is very slight and in some cases there is no effusion present. The bursæ, tendon-sheaths, and ligamentous structures are surrounded by an inflammatory exudate, which tends to become organized.

3. **Pan-articular inflammation.** This variety is the form most frequently seen, and is characterized by an acute inflammatory process which involves the synovial membrane in a serous, sero-fibrinous, hemorrhagic, or purulent inflammation; the deep layers and all peri-articular structures are infected. This form tends to become chronic, or may be chronic from the

beginning, and finally leads to varying degrees of deformity, contracture, ankylosis, and in a few cases to entire destruction of the articular surfaces.

4. Polyarticular serous effusion. While there has been no pathologic demonstration of such a condition, the repeated observation made by various writers of the existence of a primary involvement of a number of joints before the condition is well marked in any one joint shows that there exists a multiple infection which is characterized by several joints being affected simultaneously, the symptoms of the condition being pain, slight tenderness, muscular spasm, restriction of motion, and very slight effusion in the joints, which may persist for several days.

The pathologic changes are dependent more or less upon the character of the effusion present. When simple serous effusion is present, the parts are very little altered, and the condition is not attended by any marked symptoms and is followed by a complete return of normal function. In the sero-fibrinous variety there occurs a hypertrophy of the synovial membrane, accompanied by a deposit of fibrin on the synovial membrane which causes the folds of the membrane to adhere to one another, the deeper layer of the membrane and peri-articular structure are involved, new blood-vessels are formed, and granulation tissue becomes abundant, so that when organization of the fibrin occurs the intra-articular and extra-articular structures are bound together in a mass of adhesive inflammation, which ultimately leads to impairment of the joint structures and ankylosis. At times the serous or sero-fibrinous effusion may be mixed with blood, which, however, has little influence upon the ultimate results of the inflammatory process.

When the effusion becomes purulent, the condition, local and general, becomes very intense, and all the symptoms of an acute purulent arthritis are present.

There is occasionally seen a variety of gonorrheal arthritis which would be included under the classification of extra-articular inflammation. König terms it phlegmonous inflammation. This form is characterized by very little joint effusion, but in the peri-articular structures and deep layers of the synovial membrane there is a very severe inflammatory process which leads to disorganization of the joint structures, extra-articular abscesses, gonorrheal osteomyelitis, general gonorrheal septicemia, ankylosis of the joint, and in rare cases death may be the end result.

Presence of the gonococcus. Generally in the acute form, and occasionally in the chronic form, gonococci can be demonstrated in the joint effusion. They

are to be found in the phagocytes or in the epithelial cells as intra-cellular or extra-cellular bodies. Their presence, however, is more constant in the granulation tissue of the synovial membrane, and they may be found here when repeated examinations of fluid removed by aspiration fail to show their presence. Vaquez and Lanbry report three cases in which examination of the joint fluid was negative, yet ankylosis occurred, and the examination of a portion of granulation tissue from the synovial membrane obtained by arthrotomy showed them to be present in great numbers.

The view held formerly, that purulent arthritis occurring in a joint primarily infected with the gonococcus was due to a mixed infection with other pyogenic organisms, can no longer be considered to be true, since the bacteriologic studies made by H. H. Young showed conclusively that this condition was due to a pure culture of the gonococcus.

Ankylosis, when it occurs, is generally fibrous and rarely bony. When fibrous, it is due to the organization of the exudate by a process similar to the formation of stricture in the urethra. When bony ankylosis occurs, it generally follows the phlegmonous or extra-articular form of disease, in which the process has been so extensive that the joint is soon involved and marked destruction of the epiphysis occurs, and in some cases a gonorrheal osteomyelitis, as recorded by Bloodgood.

Symptoms.—The symptoms of joint involvement generally occur after the third week of the onset of the urethritis. The affection begins in most cases as a polyarticular disease. Most patients give a history of pain, restriction of motion, tenderness, and slight swelling in several joints at the onset. After a few days the symptoms increase in severity in one or several joints, and the other joints entirely recover, and when first seen the lesion is limited to only one or perhaps two joints. The involved joint is then very markedly swollen, reddened, tender, and may show fluctuation. There is increase in local and general temperature. The condition in this stage is often mistaken for acute articular rheumatism. If the effusion is serous, the local condition does not progress beyond this stage, but rapidly improves until the joint becomes normal. In most cases, however, infiltration of the entire joint structure and peri-articular tissues takes place, so that the soft parts become very much enlarged and edematous, the skin is red, glazed, and tender, and the least movement causes intense pain. Muscular spasm occurs early and the joint assumes a flexed position. This stage continues for a considerable time, until reparative processes set in, when the acute symptoms subside, moderate muscular atrophy

results, some peri-articular induration persists, and ankylosis (fibrous generally) occurs in the deformed position. If purulent inflammation is present, constitutional symptoms become marked, rupture of the synovial membrane occurs with the formation of extra-articular abscesses which may ultimately rupture at the point of least resistance.

Diagnosis.—The condition may be recognized by the history of gonorrheal urethritis, vulvo-vaginitis, or ophthalmia neonatorum, the possible history of primary polyarticular involvement followed by localization of the process in one or several joints, by the character of the swelling, and, finally, by the examination of the aspirated fluid or portions of granulation tissue obtained by arthrotomy.

Prognosis.—In the acute form suppuration and in the chronic form ankylosis are the results that are mostly to be found. The usual tendency in gonorrheal arthritis is partial or complete destruction of the synovial membrane, the formation of granulation tissue, organization of the fibrinous products, and finally, partial or complete ankylosis with ultimate impairment of the joint functions. To obtain the best functional result it is necessary to limit the process before extensive destruction of the synovial membrane has taken place. Cases in which the infection is limited to the intra-articular structures and in which the effusion is serous recover generally with good functional results. When all the intra-articular and extra-articular structures are involved and the effusion is sero-fibrinous or purulent, the prognosis as to function is very poor.

Treatment.—The line of treatment to be followed in gonorrheal arthritis depends very much upon the stage of the disease, the extent of the lesion, and the deformity present. In early cases in which the disease is limited to the intra-articular structures, is not extending, and the symptoms are not acute, the treatment consists in immobilization, preferably in plaster-of-Paris, in some cases combined with traction and the local use of ointments to assist in absorbing the effusion. Ichthyol ointment (40 to 50 per cent.), mercurial ointment, cantharideal collodion, and evaporating lotions may be of benefit. If the effusion is marked, aspiration under the most rigid aseptic precautions should be performed and careful search made for the gonococcus. If found to be present, the joint should be incised, thoroughly irrigated with salt solution or a weak solution of bichlorid of mercury, and closed with or without drainage. If the symptoms are very acute, it is advisable to open the joint and thoroughly irrigate, even though repeated examinations of the aspirated fluid fail to reveal the presence of the gonococci, as it should be remembered from the cases

cited above that they may not be demonstrated in the fluid and yet be present in the granulation tissue. In some cases after arthrotomy has been performed it may be advisable to remove extensively the involved portions of the synovial membrane. When the fluid is sero-purulent, drainage should be instituted, and continued for a number of days. It should be remembered that in order to save the function of the joint one should not wait until the disease is far advanced before performing arthrotomy, as this only relieves the infection, but this should be done early before the synovial membrane is destroyed and fibrous resolution has taken place. If this is done early, there will be very few cases with any marked limitations of motion, and practically none with ankylosis.

If the case is chronic and marked induration of the intra-articular and extra-articular structures has taken place, the course of the disease will be shortened and better functional results obtained by arthrotomy and excision of the diseased portions of the synovial membrane. If this is not considered advisable, the absorption of the exudate may be hastened by the use of hot air, massage, and passive and active movements. If ankylosis has occurred, it should be remembered that in most cases it is fibrous in character and can readily be overcome by repeated forcible movements under general anesthesia. By this means and by persistent voluntary movements a considerable range of motion may be obtained in joints in which motion is markedly restricted.

Acute Articular Rheumatism.

While the condition known as acute articular rheumatism rarely demands surgical intervention, yet it is so intimately related with certain forms of joint disease that a consideration of it will materially aid us in making differential diagnosis in certain cases. Many cases of arthritis in the early stages closely resemble this condition, and many obscure cases, the exact cause and the positive diagnosis of which are uncertain, are classified as "rheumatic" by many physicians.

Acute articular rheumatism is an affection of adolescence and of early adult and middle life. The condition may be monarticular or polyarticular. The larger joints of the body are chiefly affected in the following order: knee, ankle, elbow, wrist, shoulder, hip, and small joints of the foot and hand. The condition is often followed by endocarditis, pericarditis, pleuritis, etc.

Etiology.—The predisposing causes of this disease are exposure to cold and wet, living in damp or unhealthful surroundings, sudden chilling of the body, etc. While the evidence of the presence of a pyogenic organism as the

direct and only cause of acute articular rheumatism is not entirely proved, yet experiments made upon animals and the results compared with the similar pathologic changes observed in the joints of man show that the infectious nature of the disease is not only possible but probable. Meyer describes a diplostrep-tococcus which he believes to be the cause of rheumatism. Experiments made with this organism on the lower animals produced typical attacks of arthritis and in 21 out of 100 cases verrucose endocarditis. Other experiments have been made by different observers with various organisms with similar results. It seems very probable that, as certain forms of arthritis are due to different specific organisms which produce pathologic changes and clinical symptoms entirely distinct from each other, acute articular rheumatism is due to an organism which produces its own certain train of phenomena. It is commonly supposed that the organisms gain entry to the circulation through the tonsils.

Pathology.—The articular changes which take place in acute articular rheumatism generally involve the synovial membrane. Slight effusion is always present. Hypertrophy of the villi with thickening of the capsule takes place. The cartilage, while usually remaining intact, may become eroded in spots and present a frayed-out appearance. As the villi hypertrophy the joint cavity is increased, fibrous deposits occur, which later organize, producing in chronic cases marked contraction of the capsule. Effusion is not always present, but when it occurs it is sero-fibrinous or flocculent.

Symptoms.—The acute attack generally comes on suddenly after exposure. Several joints are involved at the same time. All the affected joints may not present the same set of symptoms. Several joints may be very painful, while others may be markedly swollen. The skin surrounding the joint is swollen, tense, reddened, and shows increased local temperature; in fact, these latter symptoms may be so severe as to suggest a suppurative arthritis. Areas of induration and subcutaneous ecchymosis may be present. The joints are held rigid, in a semi-flexed position, and all motion is prevented by marked muscular spasm. During the acute attack there is considerable constitutional disturbance and increased body-temperature. Under appropriate treatment the recovery from the acute attack is very rapid. In the chronic condition passive motion is somewhat limited and crepitus can generally be elicited over the affected joints. After long use the joint may be swollen for a few hours, when it returns to normal or may remain stationary for weeks in neglected cases. The acute condition is followed very frequently by endocarditis, pericarditis, pleurisy, and chorea.

Diagnosis.—This rests upon the acuteness of the onset, the polyarticular involvement, the absence of lymphangitis, the absence of leukocytosis, the history of previous attacks, and the rapid subsidence under appropriate treatment. The chronic form is recognized by the history of previous attacks of the acute process, by the local examination of the joints, which usually present crepitus on motion, and stiffness and moderate deformity.

Treatment.—The treatment of the acute form consists mainly in the internal administration of preparations of salicylic acid, antipyrin, arsenic, potassium iodid, etc., and in the local use of ichthyol, gaultheria, methyl salicylate, etc. Occasionally good results follow the prolonged use of various baths. Good results often follow the use of hot air, especially in the chronic cases. After the urgent symptoms have subsided careful gymnastics, massage, hot air, and electricity may be employed. Apparatus which produce complete immobilization should never be used, as they only tend to increase the stiffness in the chronic cases.

Gout.

Synonyms.—Arthritis urica; Podagra.

The constitutional disease commonly known as gout is occasionally accompanied by joint affection. While gout has always been considered as being rare in this country, the statistics of Fletcher, collected from the medical clinic of the Johns Hopkins Hospital, showing that there were 32 cases of definite gout among 14,000 patients admitted during a period of twelve years, prove that the condition is more frequent than is generally supposed.

The disease usually begins as an acute attack, lasts several days, and subsides suddenly. The metatarso-phalangeal joint of the great toe is most frequently affected, although involvement of the joints of the fingers and the knee-joint and the elbow-joint occasionally occur.

Pathology.—The pathologic changes which take place in the arthritis of gout are characteristic. There occurs an acute inflammatory process of the synovial membrane, followed by thickening, together with marked degeneration and erosion of the cartilage; at the same time a deposit of uric acid salt crystals takes place over the surface of the synovial membrane and cartilage. The destruction of the joint is due to deposits of these crystals beneath the cartilage and the formation of localized deposits of uric acid containing material resembling chalk (gout nodules, tophi). Similar deposits take place in the soft parts and true exostoses occur. The synovial membrane remains thick-

ened. The deposits become palpable and may be recognized by a sand-like grating or may produce yellow foci which are evident under the inflamed skin. Occasionally the deposits break down, suppurate, and lead to the formation of fistulas.

Symptoms.—The onset of an attack is sudden. It begins as an acute swelling of the joint, accompanied by intense pain and redness of the skin. The attack lasts several days and gradually subsides. Repetitions of the acute attacks are followed by the formation of the deposits mentioned above. At the time of the acute attack there is never any involvement of the lymphatic system or signs of inflammation in the neighboring lymph-nodes.

Diagnosis.—This depends upon the history, the sudden onset, the gradual improvement after several days, followed by the characteristic deposits, the absence of signs of acute sepsis, and the absence of constitutional symptoms.

Treatment.—While the treatment of most cases of gouty arthritis belongs to medicine, yet the surgeon is occasionally called upon to excise bursæ and to excise joints which are hopelessly deformed by the presence of uric acid deposits. Excision of joints which are very painful on account of pressure, or are ankylosed in deformed positions, is followed by marked relief, although the operation does not prevent subsequent deposits from taking place in the soft parts about the excised joint.

Hemophilia.

The occurrence of joint lesions in hemophilia is very rare. Bloodgood states that there has never been observed a case of hemophilia with joint manifestations at the Johns Hopkins Hospital, although there have been several cases of the disease treated there. The condition is usually observed in the male sex during childhood or early adult life. There is generally a family or previous personal history of hemophilia. The knee-joint is most frequently affected, although several joints may be simultaneously affected. The attack usually follows an injury or may come on suddenly and spontaneously during the night without any previous history of trauma.

Pathology.—The pathologic changes consist of hemorrhage, which may be intra-articular and extra-articular. After repeated attacks, the villi are increased and the cartilage is stained brownish and may be in a stage of degeneration, exposing the bone in places. Erosion of the ends of the bones may take place in the center combined with proliferation along the periphery. Fibrin is deposited upon the synovial membrane and cartilage and later becomes

organized, producing adhesions between the articular surface, contractures of the synovial membrane, and marked impairment of motion. If erosion of the cartilage and bone ends takes place, the destructive process may continue until complete disorganization of the joint occurs. Contractures, deformities, and ankylosis are usually the end results.

Symptoms.—In most cases there is usually the family history of hemophilia or a previous personal history of epistaxis or some other form of hemorrhage. The joint symptoms may follow injury or may occur spontaneously during the night, without pain, fever, or functional disturbance. There is considerable swelling and moderate impairment of motion. The swelling produces the ordinary symptoms of an acute synovitis. Several days after the onset there may be signs of extravasated blood around the joint. The symptoms of the attack may disappear and be followed by a succession of attacks in the same or other joints, until finally there is persistent swelling, induration of the soft parts, moderate muscular atrophy, limitation of motion, until the joint symptoms pass on to a chronic state, and finally contractures, ankylosis, and deformity occur.

Diagnosis.—The diagnosis rests upon the hemophilia history, the occurrence of an acute attack of arthritis, which may be followed by further slight attacks of swelling, pain, and perhaps subcutaneous ecchymosis appearing several days after the onset. The persistence of the condition followed by the ankylosis and deformity may aid in arriving at a correct diagnosis. The condition is often confounded with that of tuberculous knee-joint disease. König on two occasions operated on what he considered was tuberculous arthritis of the knee, and the operation was followed by almost fatal results from hemorrhage on account of the condition being hemophilia. If a surgeon of König's experience is mistaken in this condition, the difficulties that are occasionally encountered in arriving at a correct diagnosis can be readily seen.

Treatment.—During the acute attack the joint should be tightly bandaged and immobilized by a suitable splint. If repeated attacks occur, care should be taken to place the limb by appropriate apparatus in the best functional position, should ankylosis occur. The only operative treatment advisable is aspiration of the fluid and the irrigation with carbolic acid, or aspiration followed by the injection of gelatin (20 to 40 c.c. of a 2 per cent. solution) into the joint. Arthrotomy is contraindicated on account of the fatal hemorrhage which is liable to follow. Fuller reports two cases, in which after the administration of thyroid extract, in five-grain doses three times daily, there was no recurrence of the

condition. If contractures and ankylosis in deformed positions occur, forcible correction or operative interference should never be attempted. If attempts are made to overcome the deformity in the early stages by gradual extension, good results will usually follow.

Scorbutus.

Synonym.—Infantile scurvy.

The occurrence of joint disease in infantile scurvy, while uncommon, is occasionally seen. The condition is usually found among children who are poorly nourished and poorly fed. It generally occurs among children who are fed on cows' milk.

Pathology.—The pathologic changes consist of an enlargement of the end of one of the bones forming an articulation due to a periosteitis, and are accompanied by a subperiosteal hemorrhage. The process usually occurs near the epiphyseal line, and may be so extensive that epiphyseal separations may result. The process does not usually involve the joint, although a sympathetic synovitis may be present.

Symptoms.—The condition is first noticeable on account of the child complaining of pain and tenderness about the affected joint, which on examination is found to be enlarged and tender on pressure. The swelling is generally extra-articular and above the epiphysis, although some joint effusion may be present. There are no signs of an acute inflammatory condition, as local heat, redness, or edema. Peri-articular ecchymosis may be present. In addition to the joint lesions there may be marked hemorrhages beneath the mucous membranes and the skin. There is generally a coexistent condition of rachitis.

Treatment.—The chief point of treatment consists in substituting fresh milk, properly modified, to suit the case, for condensed or improperly prepared milk. To this should be added fruits and juices which contain citric acid. During the acute stage protection should be afforded the involved extremities so as to prevent epiphyseal separation or fracture, and during the convalescence the general health should be improved by massage and bathing.

CHAPTER XVII.

LATERAL CURVATURE OF THE SPINE.

Lateral curvature of the spine is a lateral deviation of the spinal column, or part of it, from the natural physiologic direction to either side of the median line, associated with a distortion of the trunk. This deviation is usually accompanied with rotation of the bodies of the vertebrae on their vertical axes, but as this is not essential, it need not necessarily form a part of the definition of the deformity. Two forms are recognized—a functional and a rotary lateral curvature.

Synonyms.—*English*, Scoliosis. *German*, Seitliche Rückgratsverkrümmung, oder Verbiegung; Bogenförmige Deformität der Wirbelsäule; Seitliche Verbiegung. *French*, Scoliose; Déviation Latérale de la Taille. *Italian*, Scoliosi. *Spanish*, Scoliosis. All of these express clearly the deformity, but for scientific purposes the term scoliosis, which was given to this affection by Hippocrates, is open to least objection, and is the one generally employed.

Frequency.

Lateral curvature is much more frequent than the ordinary observer would imagine, from the fact that by the proper arrangement of the clothing deformities of slight degree are readily concealed. It is also, without doubt, the most common of all orthopedic affections. Drachmann found in 28,125 children examined in the schools of Denmark 368 suffering from this affection, and more recently Scholder, out of 2315 school-children examined, found scoliosis present in 571. Combining, however, the 8000 cases of deformity examined by Schilling, Berend and Langaard, and Fischer, 2553 of whom suffered from scoliosis, we have a sufficiently large number to show the frequency of this affection. The relative frequency of this affection in surgical fracture is shown in the 5680 cases of orthopedic affections treated at the Dispensary of the Hospital of the University of Pennsylvania, 293 of which had scoliosis and 492 Pott's disease.

Taking the relative frequency among boys and girls, the larger percentage of the latter—about four to seven girls to one boy—has reasonably been ascribed to the greater attention given to their development, and therefore the greater

likelihood of an early recognition of the deformity, and consequently an earlier consultation with the surgeon. This statement seems to be supported by the fact that of all those cases of scoliosis seen by the surgeon, the most aggravated forms are found among males, the earlier or milder cases being found in females, though severe cases may also be found in females. The most severe form the writer has observed was in a female of thirty-five years.

This relative proportion is found from the following table to amount to 78.8 per cent.

	NUMBER EXAMINED.	BOYS.	GIRLS.
Kölliker,.....	721	144	577
Roth, ...	1000	122	878
Wildberger, ...	120	19	101
Lonsdale, ...	179	21	149
Ketch, ...	229	40	189
Berend, ...	896	123	773
Adams,.....	173	22	151
	3318	491	2816

In very young children under five years of age, the number of males was found by Redard to equal or even exceed the number of females.

The relative frequency at different periods of life is well shown by the analysis of 1000 cases made by Roth, in which he found the average age to have been 12.32 years, and the greatest number of cases (11.7 per cent.) to have occurred at the age of thirteen. Scholder practically confirms Roth's figures, for in his examination of 2315 school-children he found 571 were scoliotics, of whom 20.14 per cent. were thirteen, 18.39 per cent. were twelve, and 19.26 per cent. were eleven years of age.

Likewise in Eulenburg's 1000 collected cases, in 85.8 per cent. the deformity began before the tenth year, in 96.5 per cent. before the fourteenth year, and in only 3.5 per cent. after the fourteenth year. His figures are as follows: 78 cases from birth to the sixth year; 216 from sixth to seventh; 564 from seventh to tenth; 107 from tenth to fourteenth; 35 after the fourteenth. It therefore occurs most frequently before puberty, and more particularly between the tenth and thirteenth years of life, especially the latter.

As to the relative frequency among school-children, the following are reported:

Hagman, of Moscow, ...	in 1664 children found	29%	scoliotic.
Guillaume, of Neufchatel, ...	" 731 "	" 29%	"
Kallbach, of St. Petersburg, ...	" 2333 "	" 26%	"
Krug, of Dresden, ...	" 1418 "	" 25%	"
Scholder, of Lausanne, ...	" 2314 "	" 24.67%	"

Scoliosis is of greater frequency among the enlightened; that it is a consequence of civilization, as has been stated by several authorities, can be established, since only a few of the causes—congenital, traumatic, and pathologic—occur among savages. If, however, varieties only were considered,—as habitual, static, and professional—the statement would be accurate.

Six different forms of scoliosis may be considered, as follows:

1. Right cervical scoliosis.

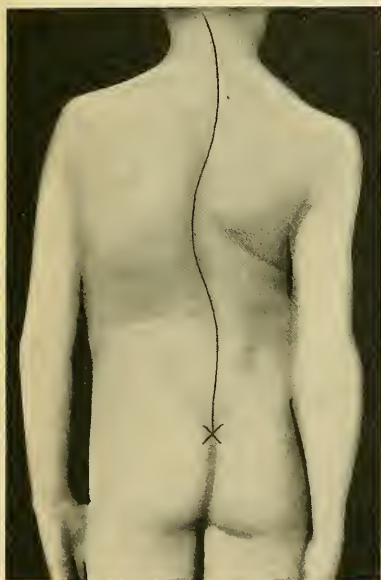


FIG. 367.—PRIMARY RIGHT CERVICAL SCOLIOSIS.

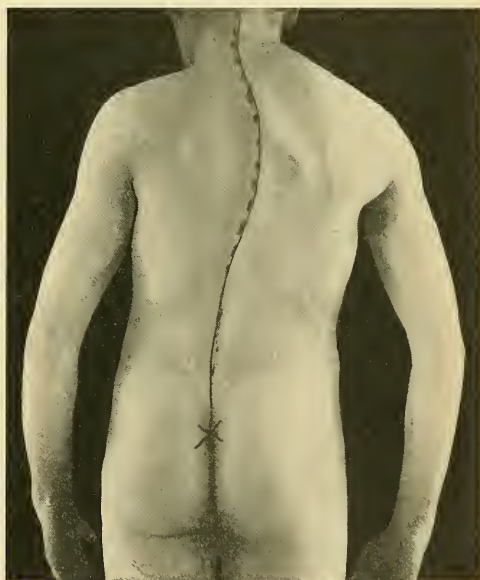


FIG. 368.—PRIMARY LEFT CERVICAL SCOLIOSIS.

2. Left cervical scoliosis.
3. Primary right dorsal scoliosis.
4. Primary left dorsal scoliosis.
5. Primary right lumbar scoliosis.
6. Primary left lumbar scoliosis.

From the anatomic construction of the vertebral column, scoliosis affects some portions of the spine more frequently than others, the right dorsal scoliosis being by far the most frequent as a primary affection, and left primary lumbar

scoliosis next in order. The proportion of cases of primary right dorsal scoliosis has been variously estimated from 42.3 per cent. (Drachmann) to 92.7 per cent. (Eulenberg). Schulthess found 90 per cent. left, as against 10 per cent. right. It is probable that primary left lumbar scoliosis is relatively more frequent than has been supposed, Lorenz having found 38 per cent., Drachmann 47.7 per cent., and Klopsch 57 per cent. in their investigations. As primary curves they



FIG. 369.—PRIMARY RIGHT DORSAL SCLIOSIS.



FIG. 370.—PRIMARY LEFT DORSAL SCLIOSIS.

rarely exist for any length of time, being sooner or later associated with a rotation of the bodies of the vertebrae, and a secondary or even tertiary compensatory curve to enable the column to maintain its equilibrium. Scholder in 571 school-children found that 401, or 70.3 per cent., were single left-sided; 121, or 21.1 per cent., were single right-sided; and 49, or 8.6 per cent., were combined curves. According to Krug, 67 per cent. were left, 21 per cent. were right, and 12 per cent. were combined.

Etiology.

Congenital scoliosis, though rare, does occur as a consequence of other deformity or as a primary malformation—a *vitium primæ formationis*—instances of which have been recorded. In Willett's case, an adult of thirty-five years, the deformity was believed to be due to an early embryologic defect in the elements forming the lateral and vertebral plates. Heredity is a frequent cause, especially in the scoliosis observed in young girls, about 25 per cent. being due to this cause. Hereditary examples of two or more members of a family,



FIG. 371.—PRIMARY RIGHT LUMBAR SCOLIOSIS.

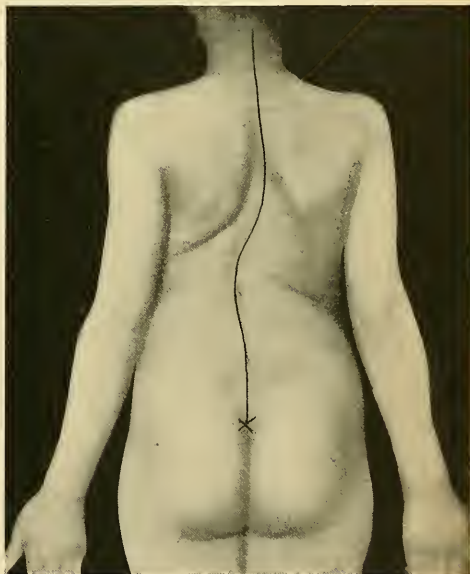


FIG. 372.—PRIMARY LEFT LUMBAR SCOLIOSIS.

while the mother or father also present a similar deformity, are numerous and familiar to all.

By far the greater number, however, are acquired. As an acquired affection it arises from many and various causes, the most common among the predisposing being sex. Thus, the deformity is observed more frequently in girls than in boys—according to the statistics, in about the proportion of between four and seven to one. Age is also a predisposing cause.

General muscular debility in adult cases has but little weight, since the

weak and delicate, unless as an acquired cachexia or diathesis the result of prolonged disease, do not suffer more frequently than the strong, muscular, and robust. This was particularly marked in several cases in unusually well-developed boys observed by the writer. In the majority of cases in the young, and especially in females, the muscular development is decidedly below par, the digestion is feeble, the circulation poor, and they are subject to cold hands and feet, intercostal neuralgias, and occipital headaches.



FIG. 373.—STATUE OF BOY FROM POMPEII SHOWING ATTITUDE OF REST.

This cannot be said, however, of the general debility resulting from rachitis, which has been considered recently by one authority as one of the most common predisposing causes. When the number of bow-leg and knock-knee patients is considered, it is remarkable that lateral bending of the osseous spinal column does not with greater frequency yield to like causes. This, it may be suggested, may be due to the enlarged abdomen and ligamentous relaxation, tending toward a posterior curvature rather than a lateral deviation.

Later, as exciting causes, the direct results of rachitis—bow-legs and knock-knees, anterior bowing of the femur and tibia, flat-foot, etc.—contribute their quota to the number of curvature cases. The habitual position in which infants are carried is particularly liable to produce scoliosis, especially in rachitic cases.

Under exciting causes also may be reckoned all those influences which in any manner disturb the equilibrium of the spinal column, and which give to the muscles of one side an advantage over their antagonists. These may be conveniently classed in the order of importance and frequency, under habitual, static, professional or vocational, pathologic, and traumatic.

The **habit scoliosis** which results from the partial or unequal use of the muscular system is equally, if not more, common among the tailor-made society misses reared and instructed in the environment of a Procrustean atmosphere, and the factory slave unaffected by proprieties but compelled by necessity to assume cramped positions for long periods under the most unhygienic surround-

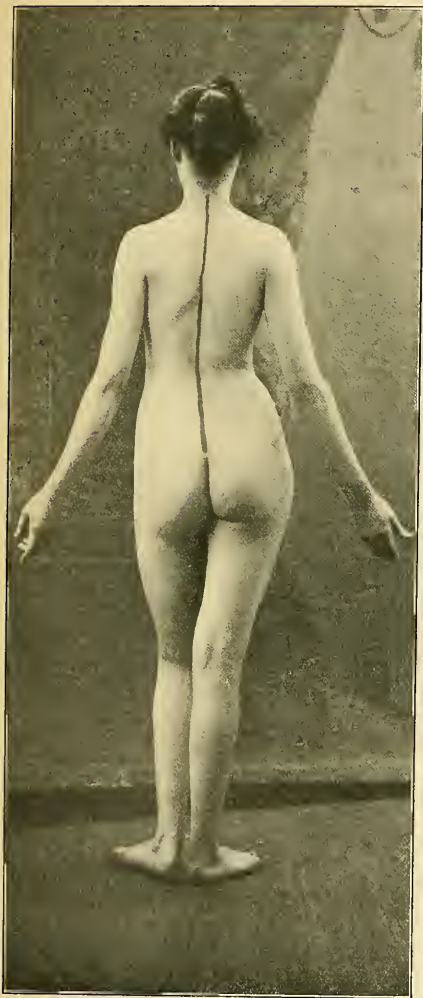


FIG. 374.—CURVE CAUSED BY FAULTY ATTITUDE.



FIG. 375.—SAME CASE, SHOWING CORRECTED ATTITUDE.

ings. On the one hand, these habitual faulty positions are assumed through carelessness; on the other, through fatigue. This attitude of rest or fatigue, which I have designated the "American position," is very commonly depicted in works of art. Illustrations of this are seen in such statues as the Venus in the Naples Museum, the Venus in the Uffizi Gallery, and in the Boy from Pompeii. This attitude of rest is also observed in the paper currency issued by the United States Government in 1898, where two figures are shown standing in this manner. It is also frequently observed in soldiers' monuments, and in many statues of distinguished men. That this habitual faulty attitude is productive of lateral curvature is proved in instances of artist's models who have become deformed from assuming this position for long periods. The exact manner in which a faulty attitude produces lateral curvature is not difficult of explanation. The constant standing upon one foot—as, for example, the left—leads to an elongation of the flexed and relaxed member, so that when the standing position is assumed the relaxed limb is apparently longer than the one upon which the weight has rested. Moreover, the elongated one will be found to be larger in circumference and the muscles relaxed and softened. Habitual faulty positions, therefore, constitute by far the larger number of cases. Under this class belong also those cases resulting from lateral posture assumed to relieve ovarian pain (usually left), and to relieve pain and distention from enlarged spleen.

Static scoliosis, or inequality resulting from alterations of one extremity, is next in importance. Whatever produces a shortening of one lower extremity produces an obliquity of the pelvis in the opposite direction, and a primary deviation of the lumbar vertebrae. This may result from destructive changes in the joints, rachitic curves and bowing, flat-foot, back-knee from ligamentous relaxation, or in consequence of excisions or amputations of either the lower or upper extremities. The exact production of scoliosis in cases of amputation is difficult to explain satisfactorily, since a person with an amputated arm may have scoliosis, while another with an amputated leg may not. The existence of a short leg from unilateral development is also very frequent, since Morton found in 513 healthy boys measured, 272 with inequality in the length of their legs, and Garson, in London, in measuring the leg bones in 70 skeletons found only 10 per cent. with legs of equal length.

Professional or vocational scoliosis, so called, results from oblique positions assumed during occupations. Particularly fruitful of deformity are the faulty positions assumed during writing, violin-playing, and the oblique

attitudes required in bearing burdens. Among these may be mentioned musicians—especially violinists—dentists, barbers, nurses, cow-boys, drug clerks, dressmakers, loom-workers, girls who ride horseback, persons born in the tropics, jewelers, umbrella-makers, professional models, etc. Those whose occupation requires them to bear heavy burdens upon one side are liable to acquire lateral curvature especially in their youth, among which Bishop has called attention to “water-men, waiters, harp-players, porters, and London milkmen,” and Ridlon has noted the absence of curvature in men who carry heavy kegs of beer upon the same shoulder during many years. In my opinion the absence of any curvature in these instances is due to the fact that this occupation is not adopted until the individual has arrived at adult life, when the body is fully formed.

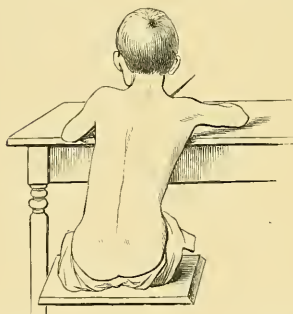


FIG. 376.—FAULTY POSITION TENDING TO RIGHT-SIDED TOTAL SCLIOSIS (Hoffa).

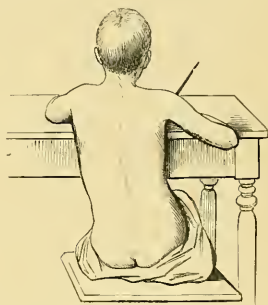


FIG. 377.—FAULTY POSITION TENDING TO DOUBLE CURVE (Hoffa).

In the Siamese twins the lateral curvature resulted from the effort which each made to give the other more space in standing, the one shoulder of each, on opposite sides, being always elevated. The same condition has been observed in twin sisters who were crowded in a narrow school seat and who rested continually upon opposite elbows in endeavoring to make room for each other. I have also noted the same condition in two Irish brothers, the one left-handed and the other right-handed, who sat in the same seat at school, and who developed curvature in the opposite direction from the elevation of the shoulders.

Pathologic scoliosis is exceptional, but may result from certain inflammatory conditions, such as torticollis; cicatrices from burns; phlegmons; caries or necrosis of ribs, etc.; pleuritic affections, especially empyema. Pleural pneumonia is a very frequent source of lateral curvature, the cicatricial con-

traction producing a marked depression and fixation of the affected side with an undue development of the normal side of the chest. Certain muscular conditions, as spasms; unilateral muscular atrophy and hypertrophy; muscular rheumatism (myositis); sciatica and other nerve conditions; neurotic changes, either akinetic or hyperkinetic, especially the former, of which anterior poliomyelitis is the commonest example, may cause scoliosis. In infantile paralysis the curvature may result in two ways: first, from the paralysis of the muscles upon one side of the spine, and, second, from the inequality of the lower extremities produced by the atrophy of the affected limb. Morbid growths of the sides of the pelvis or trunk—as encephaloid, enchondroma or sarcoma—by their enormous weight; and sacro-iliac disease from the habitual faulty position assumed to relieve suffering, may produce scoliosis.

Among the rare causes of scoliosis should be mentioned that form resulting from neuromuscular changes—*scoliosis neuromuscularia ischiadica*, described by Beely. This condition is, in my observation, usually a peripheral neuritis, the result of exposure to great and sudden changes of temperature.

Hysteric scoliosis is also exceedingly rare, but is occasionally observed.

Trauma is exceedingly rare as a cause, since fractures of the bodies or processes of the vertebrae are more liable to produce anteroposterior curvature. Non-reduced lateral dislocations would lead to permanent lateral deformity, as might also gunshot wounds of this region.

Pathology.

The pathologic anatomy of advanced scoliosis includes changes in the osseous, ligamentous, inter-cartilaginous, and muscular structures in the order of importance. In the early stages the change is probably first in the inter-cartilaginous disks.

The lesions which occur during the early stages are necessarily poorly understood, from the difficulty of obtaining post-mortem specimens at this period.

It is important to study the normal curves, and the rotation of the bodies of the vertebrae in the normal spine, in order to understand the occurrence of rotation in lateral curvature.



FIG. 378.—SEVERE SCOLIOSIS FROM EMPYEMA.

At birth the primary curves are in the dorsal region and are produced by the shape of the bodies of the vertebrae in this region. Cervical and lumbar curves develop after birth, being secondary or compensatory curves for the purpose of re-establishing the equilibrium, the changes taking place by compression of the intervertebral disks. A slight lateral curve is normal in the dorsal region, being chiefly due to muscular action, as pointed out by Bichet, whose theory was confirmed by Bechard, who found a left lateral curve in one or two individuals who were left-handed. In some instances a number of small curves may be observed which are usually associated with neurasthenia, and which indicate a weak back, not necessarily a lateral curvature. The writer has observed this condition in a patient upon whom an unsuccessful attempt had been made to correct a lateral curvature by means of machines.

Rotation of the bodies of the vertebrae occurs in the normal spine because the anterior part of the column is freely movable in the cavity of the abdomen and chest, while the posterior part is fixed by the attachment of the muscles, fascias, ribs, etc. The rotation which occurs physiologically is produced in a single vertebra by a lateral movement of the body, which is three times as much as the movement of the process. The rotation does not occur upon a central axis of the body of the vertebra, nor does it occur upon a central axis passing through the spinal canal, but, according to Judson, it rotates upon an axis somewhat remote from the periphery and at a point indeterminable and probably variable. The rotation varies in different parts of the column, and it is claimed that in the cervical region no rotation occurs because there is no cavity corresponding to the abdominal and thoracic cavities. From the experiments of Lovett it would appear to be conclusively proved that lateral bending as a single movement is impossible. When the body is bent sideways, it is accomplished by a combination with rotation. Torsion occurs by a combination of these two movements, and is best illustrated by the bending of a flat, flexible object in the direction of its width. The bending of an object of this kind shows that when bent in the direction of its width, rotation upon its axis must occur. It has been further demonstrated that a soldier, for example, can only accomplish side-bending in the extended position, torsion being best accomplished when the body is flexed at about 15 degrees.

In order to study the loss of equilibrium in lateral curvature it is necessary to keep in mind the constant balancing of the body which maintains the center of gravity. I have corroborated the experiments of Weber in regard to the center of gravity in the horizontal and vertical positions. It was asserted that the

center of gravity would fall between the feet, and that when the feet were equally inclined and equally advanced the distance between the heels would correspond to the length of the foot, and the angle would be exactly 60 degrees. In this position the equilibrium is most easily sustained. If the heels are brought together, the angle is changed to 45 degrees.

In order to determine the angle of inclination, if the mediotarsal joint is used as the base-line and a perpendicular is erected to the axis of the calcaneum, an imaginary line being drawn through the foot longitudinally, as was done by Bishop in determining the angle, it will be found that the angle will be 60 degrees when the heels are placed together.

That occupation is sometimes responsible for the occurrence of lateral curvature is shown in the fact that in carrying heavy weights, and at the same time endeavoring to maintain the equilibrium, the body deviates to the opposite side of the vertical plane, thus producing a curvature.

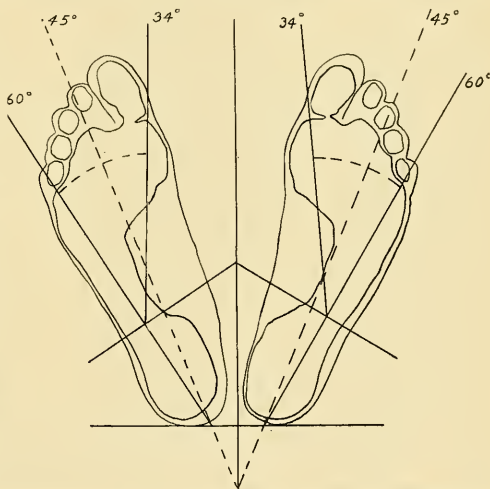


FIG. 379.—OUTLINE OF FEET, SHOWING ANGLE OF INCLINATION, AND ALSO ANGLE OF FEET IN STANDING.

In a well-marked specimen the following changes are observed: The vertebrae are rotated horizontally, the excess of the displacement being in the anterior portion (the bodies). The spinous processes being comparatively fixed, any motion of the column is observed to result in a torsion or rotation of the bodies of the vertebrae. This is in all probability what occurs in man, since the human spine is endowed with but a slight degree of pure sidewise motion, so fully developed in amphibia, in reptiles, and in some mammals. The concave side of the body is atrophied, and in some cases ossified to the adjacent vertebra by a mild pressure osteitis, the result being a wedge-shaped body with the base toward the convexity. The root of the arch is shortened on the side, the vertebral canal is ovoidal from pressure, and even the bony fibers of the body occupy a peculiar

oblique instead of an upright position. The ribs being patched to the vertebrae, are also much altered in general outline. On the concave side they are depressed, the angle is more acute, and may be united where they approximate

by synostoses. On the convex side they are depressed, widely separated from each other, and the angle is obtuse. From these changes in the vertebrae and ribs, the axis of the cavity of the thorax is oblique, the horizontal section representing an ellipsoid the greater axis of which is formed by the convex curvature, the lesser by the concave diameter.

The pelvis occupies an oblique position in the static cases, but in others it is more often horizontal than is generally believed. The changes occurring in the intervertebral disks take place early, and are marked. When we consider that the total thickness of all the intervertebral bodies forms about one-fourth of the spinal column exclusive of the first two vertebrae, and that the effect of the pressure of the body in the upright position for some time reduces them more than one-fourth of their proper size, the effect of lateral pressure long continued is readily appreciated—they become wedge-

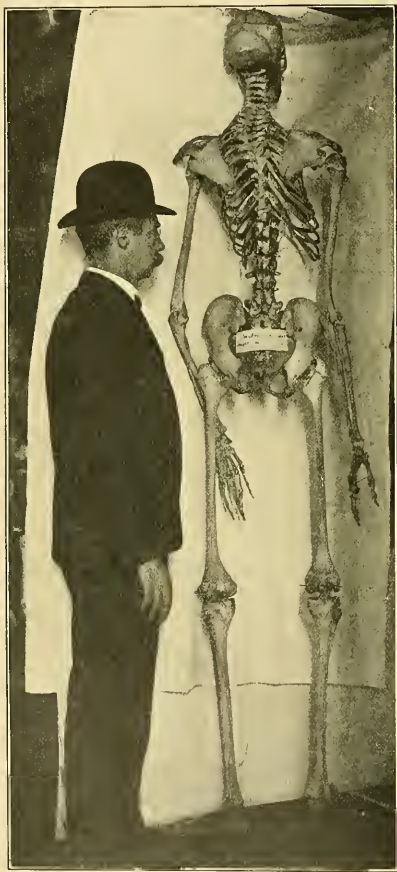


FIG. 380.—SCOLIOSIS IN KENTUCKY GIANT (Specimen in Philadelphia College of Physicians).

shaped and lose their elasticity and ability to return to a normal position.

The ligaments connecting the vertebrae (especially the inter-transverse and lateral) and connecting the ribs to the vertebrae are shortened on the con-

cavity and lengthened on the convexity of the curve. The muscles on the convexity are relaxed, fatty degenerated, and atrophied, and on the concavity contracted, but altered to a less degree. The relations of the long dorsal spinal muscles are stretched and lengthened on the convex side, and contracted and shortened on the concave.

The flat muscles adapt themselves to the changes—the rhomboidei, trapezius, latissimus, and serratus major et minor being thinned and atrophied over the bulging parts, and shortened and thickened over the depression.

All the ligaments of the body are stretched and relaxed, giving rise at the knee to a condition of back-knee, and in



FIG. 381.—SPECIMEN OF SCOLIOSIS SHOWING WEDGE-SHAPED FORMATION OF VERTEBRAS (Wistar Institute of Anatomy).

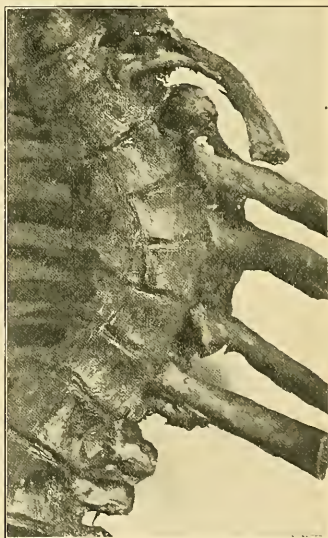


FIG. 382.—LATERAL CURVATURE SHOWING WEDGE-SHAPED BODIES.

the elbow to the condition of hyperextension which is so frequently found to be associated with lateral curvature.

The effect of lateral curvature is to cause displacements of the thoracic, abdominal, and pelvic viscera. The lungs are compressed on the side of the convexity, and the heart in severe cases is displaced toward the concave side. According to Adams, scoliosis leads to phthisis or a phthisical diathesis, but he admits the absence of statistics to prove a fact also contradicted by specialists

upon lung disease, who may not see these cases, since the writer has himself lost cases of scoliosis from this cause. The stomach, intestines, and liver are displaced downward, and the spleen and the kidney upon the convex side are usually smaller than normal.

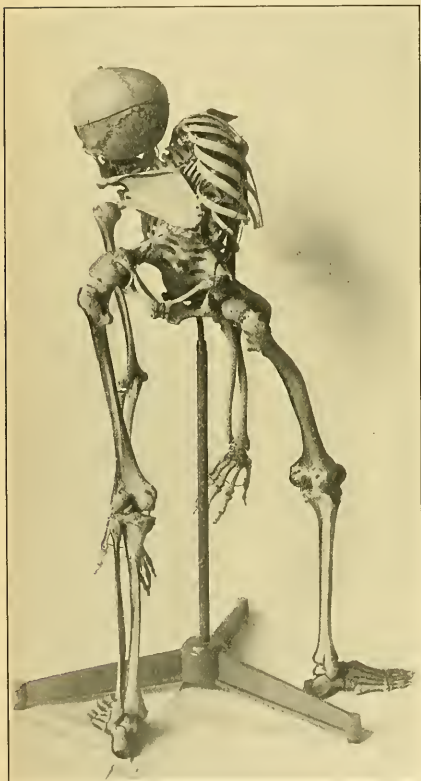


FIG. 383.—SEVERE SCOLIOSIS (Hirst). (Wistar Institute of Anatomy.)

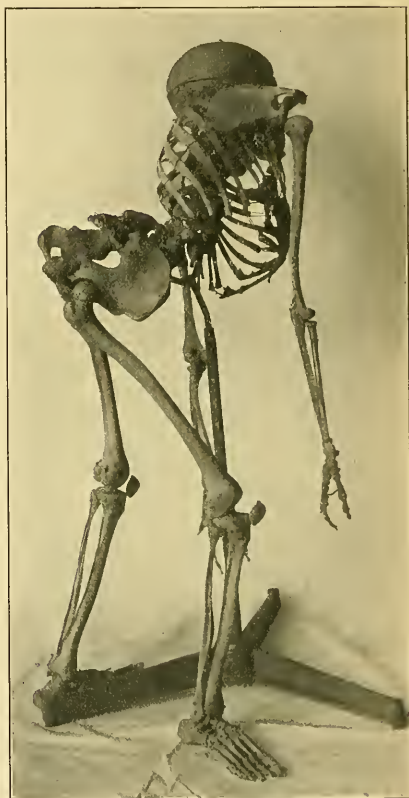


FIG. 384.—SAME, LATERAL VIEW (Hirst). (Wistar Institute of Anatomy.)

These pathologic changes illustrate the results of the faulty position, but contribute little evidence as to the real etiology of the affection. The theories proposed are very numerous, and furnish, as Copeland facetiously remarks, material for a keen satire on the medical art; but the theory of superincumbent

weight or pressure is applicable to the majority of cases, and is the one now generally accepted by writers.

The theories may, however, be included under five heads: the muscular theory, the ligamentous theory, the osseous theory, the theory of unilateral development, and the theory of pressure or superincumbent weight.

The muscular theory of unequal primary muscular action has been advanced and defended from time to time by a host of writers. The idea of an active muscular contraction identical with torticollis, supported by Guérin and others, was shown to be based upon false premises. The unilateral relatively stronger action of the right serratus which formed the basis of Stromeier's respiratory theory has been sufficiently refuted by the absence of anatomic and clinical facts, and by the arguments of Werner. The modified form of the muscular theory advanced by Eulenberg has much to recommend it. It assumes that, inasmuch as continuous muscular action is necessary to maintain the erect position, if any muscle be weakened the spinal column will tend to bend, the convexity falling on the weaker side, overstretching the muscles upon this side, and if continued for a time would cause permanent distortion.

Evidence of changed electric reactions and primary weakness of the muscles either is wanting or has not been demonstrated in the early cases. While primary muscular relaxation may not be accepted as an actual cause, its importance as a predisposing factor in static cases cannot be overestimated.

Secondary muscular changes, such as atrophy due to degeneration of the cord, or as the result of a disturbance of central trophic innervation, are accepted by all.

The ligamentous theory. The importance of the intervertebral ligaments in the etiology has never been appreciated. The highly elastic property of the yellow elastic tissue which composes some of these, especially the ligamenta subflava, serves to preserve the erect posture and to restore the spine after flexion. In static cases with feeble muscular system, when the spinal column is placed in the attitude of rest the ligaments sustain almost the entire weight and gradually yield and assume a curvature in the direction of the habitual position of the patient. This condition is identical with that which occurs in static cases of knock-knee, and while thoroughly tenable in all its parts, has not received the support of authority.

The osseous theory, which attributes scoliosis to an insidious inflammatory softening, the patient instinctively assuming a lateral position to avoid pressure, has been maintained by some observers. Cases are rare in which the patho-

logic findings correspond to this theory, and most authorities doubt its existence or confound lateral curvature with lateral deviation in Pott's disease, and in scoliosis the cancellous tissue does not present a trace of inflammation or sclerosis. A modification of the osseous theory is met in Hueter's theory of symmetric pressure from growth of the ribs. Numerous objections have been raised against this theory, and Lorenz and others have proved its fallacy by the discovery of primary osseous deviations of other vertebrae, the absence of changes in the costal cartilages, the inability of the ribs to make pressure from before backward and from without inward, the frequency of other forms, as cervical and lumbar, and from the absence of the osseous deformations characteristic of the theory. The osseous changes occurring in scoliosis can all be accounted for by Wolf's law.

The theory of unilateral development, that scoliosis is only a pathologic increase of what is physiologic, has been supported by many eminent writers.

According to most anatomists, the spine has a slight lateral curvature about the fourth or fifth dorsal vertebra, the convexity of which is directed toward the right side, being produced chiefly by muscular action, the right side being used by most persons by preference to the left, and different observers having found in one or two individuals who were left-handed the lateral curvature directed to the left side. According to some, scoliosis results from an exaggeration of this, which others considered to be due to the course of the aorta, while others attributed it to the more rapid growth of the right half of the body or to the increased weight of the organs on the right side.

Albrecht has shown that the right upper extremity of the fetus of all mammals has a better blood-supply, which results in exaggeration of nutrition and physiologic dorsal right curvature. If, as has been pointed out, it is not certain that the right dorsal curvature is physiologic in youth, if also we consider the frequency of primary cervical and dorsal curves and the occurrence of left scoliosis in persons who are not left-handed, but little importance can be accorded to the physiologic theory of scoliosis.

The theory of pressure or superincumbent weight, which assumes the gradual transformation of the normal spine under mechanical influences falling obliquely upon it through faulty attitude, is accepted by most authors at the present time, and has been advocated especially by Volkmann, Roser, and others, and this the writer supports, giving especial importance to the ligaments in the secondary changes which occur.

Any asymmetry of development or faulty posture which causes the spine

to deviate from the median line, and which destroys the equilibrium of the spinal column, may be looked upon as a predisposing cause, and the superincumbent weight of the body as the direct etiologic factor in the production of this affection.



FIG. 385.—LEFT LUMBAR SCIOLIOSIS, SHOWING LOW SHOULDER (Spel-lissy).

Clinical History and Symptomatology.

The lateral curvature or rotation of the vertebrae are rarely first observed. Usually the dressmaker or tailor discovers an inequality of one shoulder, or a growing out of one hip, and, these being further investigated by the surgeon, the true nature of the affection is at once revealed.



FIG. 386 —RIGHT LUMBAR SCIOLIOSIS, MILD DEGREE.

In girls great difficulty is experienced in fitting waists, plaid goods, sailor collars, and garments that are turned in making. They may be easily fatigued, complain of muscular weakness, and be disposed to recline or rest much of the time; or

a boy complains of one suspender shoulder-strap constantly slipping, or one trouser leg wearing out at the bottom, or a girl of her inability to keep the shoulder-straps in position or to have her skirts made even on both sides. In some a limp is noticeable and others walk in a sideways manner. This should at once direct attention to the spine, and in slight cases the following changes will be noted:

In one of the most common varieties—the left primary lumbar curvature—the waist-line on the left is flattened or obliterated, and on the right deepened, and the waist-angle rendered more acute.



FIG. 387.—SEVERE DORSO-LUMBAR LATERAL CURVATURE.



FIG. 388.—LEFT LUMBAR SCOLIOSIS, SHOWING HIGH HIP (Spelissy).

The crest of the right hip becomes more prominent, and the crest of the left disappears. From a rotation of the vertebrae the left lumbar region becomes

fuller, and the right flattened. Later, as the compensatory dorsal curve forms, the body placed in Adams' position (strongly flexed forward) reveals the serpentine course of the spinous processes, and the erector spinæ mass of muscles is flattened on the left from the deviation forward of the transverse processes.

In this form, as in almost all cases of scoliosis, the first curve is known as the primary curve, to distinguish it from the other curves which afterward form, and which are distinguished as secondary or compensatory curves.

Right convex dorsal scoliosis, very frequently a primary affection, gives symptoms still more pronounced. In the slight cases the ribs on the right side are more prominent, the scapula projects slightly backward, the left hip is a

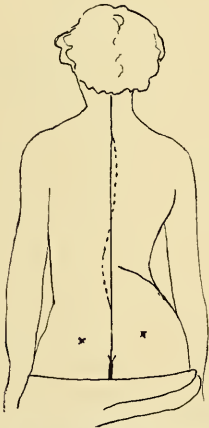


FIG. 389.—LEFT LUMBAR SCOLIOSIS. FIRST STAGE—RIGHT SHOULDER DEPRESSED.

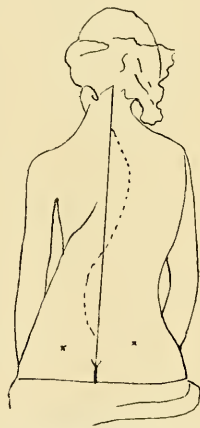


FIG. 390.—SAME, SECOND STAGE—RIGHT SHOULDER ELEVATED.

little more prominent, and spinous processes in Adams' position are curved slightly (convexly) to the right. In right dorsal curvature secondary to left lumbar scoliosis the position of the shoulders differs at different periods of the deformity. During the first stage the right shoulder is depressed, but later when the compensatory curve becomes more marked the left shoulder becomes depressed and the right shoulder is elevated. In severe cases these changes are increased and augmented by others.

The right costal angle is increased in extent and prominent, and the left flattened and decreased. The conformation of the anterior part of the chest is affected, but to a less degree than the posterior, and the breasts are unsym-

metrically placed, the left being usually more prominent and higher. The abdomen is less prominent on the left, and the umbilicus is displaced to one side. The left scapula, more prominent, is elevated and projected backward, while the less prominent left scapula approaches the median line and is flattened. With the formation of a secondary compensating lumbar curve, the

alterations before described under primary left lumbar scoliosis are superadded. And later, with the formation of a compensatory left convex



FIG. 391.—RIGHT DORSAL SCOLIOSIS, MILD DEGREE (Spelissy).



FIG. 392.—RIGHT DORSAL SCOLIOSIS, SEVERE DEGREE (Spelissy).



FIG. 393.—LEFT DORSAL SCOLIOSIS, SEVERE DEGREE, IN A BOY (Spellissy).

cervical curve, the outline of the shoulder and neck is altered, and the normal beautifully curved shoulder-line is changed; it is more curved on the right, the shoulder more prominent, the neck longer; on the left it is flattened, the shoulder is less rounded, and the neck shorter.

The exact process by which a cervical curvature from wry-neck induces a lateral curvature of the entire column is interesting. The deviation of the

head to one side and the flexion of the chin upon the thorax by the unilateral contraction induce a bowing of the cervical vertebrae to that side and rotation of the bodies upon one another. There is at once produced a characteristic alteration in the outline of the neck—the graceful double curve becomes flattened, the neck shortened, and the shoulder less prominent on the one side, while the curved line becomes more pronounced, the neck longer, and the shoulder more prominent on the other side.

The natural balance of the column being disturbed, Nature endeavors by

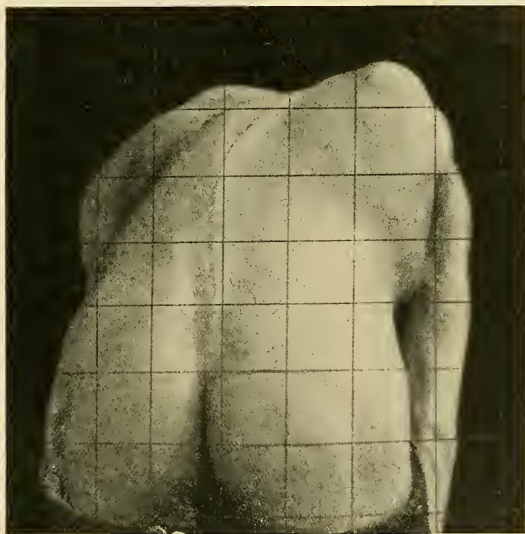


FIG. 394.—RIGHT DORSAL SCLIOSIS. ADAMS' POSITION, SHOWING ROTATION.

a compensatory dorsal curve to restore the equilibrium. This induces a rotation of the bodies of the dorsal vertebrae with all its attendant deforming features: the flattening and twisting of the scapula on one side, the deviation of the spinous processes in a serpentine direction from the median line, and the elevation and projection backward of the scapula on the other side. With the development of a third or lumbar curve the crest of the hip becomes obliterated on one side, the waist-line deepens, the hip becomes prominent on the other side, and the lateral outlines become everywhere less symmetric.

It is popularly believed by the superstitious that persons suffering from

lateral curvature possess great intelligence, bad tempers, and intense venereal capabilities. Though these qualities, for obvious reasons, are more or less frequently associated with tuberculous caries of the vertebrae, they do not apply to sufferers from lateral curvature, who in other respects seldom differ from healthy individuals.

In severe cases, in addition to the inconvenience and discomfort of the lateral deformity, actual pain in different parts of the spine—occasionally referred to the peripheral distribution of the spinal nerves from intervertebral pressure—and thorax from nervous pressure may be experienced; and dyspnea, emphysema, catarrhal bronchitis, pneumonia, and palpitation of the heart may be complained of. In patients under twelve years of age chorea has been observed by the writer. Venous stasis in the extension vascular system of the spinal canal is responsible for the occipital headache and neuralgias which are so constant, as well as for the menstrual disturbances which form an integral part of the symptomatology of this affection. The digestion may be impaired, the appetite capricious, and the patient nervous or neurasthenic; while, on the other hand, aside from the deformity, they may occasionally enjoy comparatively perfect health.

Three stages of the affection may be distinguished:

First stage, or initial stage.

Second stage, or stage of development.

Third stage, or stage of arrest.

The first stage in ordinary juvenile cases extends from the beginning of the affection—from the sixth to the twelfth year—to puberty; the second stage from puberty until the nineteenth to twenty-first year, the period of the establishment of growth; and the third stage includes the period after the completion of the developmental age.

Diagnosis.

The importance of a correct early diagnosis cannot be overestimated, since it is the early stages which offer the most hope of perfect restoration. The examination should be conducted in a good light, and the contour and outlines of the trunk should be examined from different positions in front and behind. For this purpose the patient, if a child, should be freely exposed to below the trochanters, and the clothing conveniently secured by means of an ordinary roller bandage. The relation of the spinous processes should be carefully observed and marked while the patient, standing erect, bends far forward until

the trunk is horizontal (Adams' position), or practises self-suspension from a bar or Sayre apparatus. The inequality of the lower extremities may be tested by thin boards or books placed under the feet, or with the author's machine for measuring inequality, described under unilateral development, while a rule or spirit-level estimates the amount of obliquity of the iliac spines. If doubt exists, or any inequality be discovered, the upper part of the body may be covered, and upon a hard couch the exact measurements of the lower extremities from the anterior superior spinous processes or umbilicus be taken.

Mensuration and Recording Methods.—Many methods have been devised for measuring and recording the amount of deformity, by means of more or less complicated apparatus, of which I have recently collected a table including no less than 68 appliances of various forms, as follows:

TABLE OF SCOLIOSOMETRY.

- I. Pliable reproduction,....(1) Plaster Cast. (Delpech; Heine.)
 (2) Model Bandage. (Beely.)
 (3) Bas Relief.
 (4) Segmentary Plaster Strip Impression. (Dollinger.)
 (5) Plate Moulding. (Hubscher.)
- II. Perspective drawing,....(1) Freehand drawing.
 (2) Photography.
 Plain. (Berend.)
 Screen. (Spellissy; Young; Hovorka.)
 Roentgen Ray. (Kraus; Kienback.)
 Stereoscopic. (Schanz.)
 Radiography. (Hoffa; Baer.)
 Screen Radiography. (Joachimsthal.)
 Orthodiagraphy.
- III. Measuring,.....(1) Simple Measuring of the Body.
 Measuring Band. (Schanz; Sargent.)
 Calipers. (Schulthess; Reiner.)
 Leveling Trapez. (Schulthess.)
 Spirit Level.
 Water Level.
 Glass Tubes.
 Pendulum Rod. (Heinecke.)
 Plummet. (Buhrings.)
 (2) Outside Measuring of the Body.
 Pliable Metal Band.
 Scoliosometer. (Mikulicz; Beely-Kirchoff.)
 Simple Co-ordination Apparatus. (Weil; Pansch.)
 Measuring Apparatus. (Biggs.)
 Diastropometrie. (Roberts.)
 Scoliosometer. (Zander; Bradford.)
- IV. Profile drawing(1) General Surface Measuring.
 Cyrtometer. (Voillez.)
 Lead Strip. (Schildbach.)

TABLE OF SCOLIOSOMETRY.—(*Continued*).Profile drawing,—(*Continued*). (2) Special Surface Measuring.

Tin Strip. (Roth.)
 Rod Cyrtometer. (Beely; Elkinton-Young; Murray.)
 Glass Plate. (Buhrings; Milo; Ghillini; Lange.)
 Camera Obscura. (Schildbach.)
 Camera Lucida. (Wollaston; Epper; Grunbaum.)
 Silhouette. (Theslow.)
 Notograph. (Virchow; Elkinton-Young; Seeger; Murray; Weigel; Rausch.)
 Scoliosis Gauze. (Barwell.)
 Scoliosometer. (Schulthess.)
 Thoracograph. (Socin and Burkart; Schenk; Hubscher.)
 Tachygraph. (Beondetti; Scudder; Walther.)
 Pantograph. (Hall.)
 Thoracometer. (Heinleth.)

This table I have corrected from Hovorka and Hoffa, and it includes all methods of measuring from the simplest freehand drawing to the most elaborate and precise mathematical instruments.

The ordinary cyrtometer used by clinicians to measure the chest, or an ordinary lead measure with

freehand sketching, has been found by the writer to answer all practical purposes, but for scientific records more accurate measurements are available.

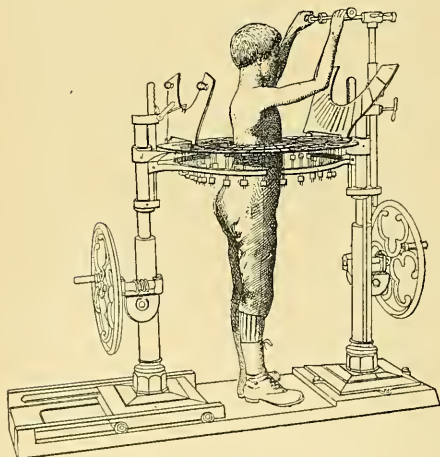


FIG. 395.—SCOLIOSOMETER OF ZANDER.

The taking of plaster casts of the body is tedious and cumbersome. The camera obscura reproduces only a portion of the deformity, and photographic reproductions are variable, for obvious reasons, so that mechanical devices offer the best means of illustrating the deviations.

The methods most frequently employed are the lead measuring strip, the cyrtometer, freehand drawing, photography, McLaren's measurements, Weigel's trolley machine, and Beely's scoliosometer. Of these, the cyrtometer is simple and reliable, and Beely's scoliosometer is satisfactory, but could be improved by attaching it to a table. The most satisfactory methods at the present time

are Sargent's anthropometrical measurements, photography through a screen, Bradford's scoliosometer, and the Elkinton-Young improved trolley delineator and rod scoliosometer.

1. **Sargent's Charts.**—The advantages of this system of measurements are that they give not only the average measurements for the given age and weight of the individual, but the two sides of the body may be compared and any defect or unilateral development may be readily detected.

2. **Photography through a Screen.**—By this method a photograph may

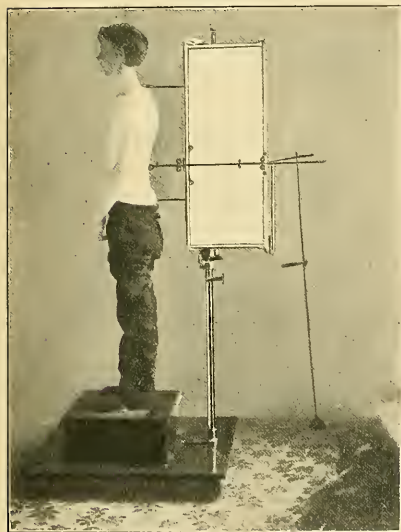


FIG. 396.—IMPROVED TROLLEY DELINEATOR, VERTICAL POSITION.

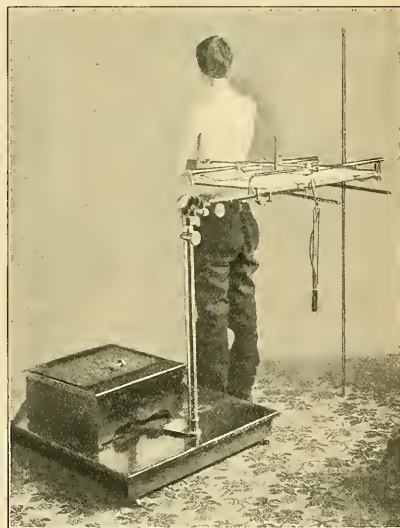


FIG. 397.—IMPROVED TROLLEY DELINEATOR, HORIZONTAL POSITION.

be taken through a screen made of threads, or, first, lines may be made upon sensitized paper, and, second, the patient photographed upon the same paper, as devised by Spellissy. Photography of this kind requires that the position of the stand, screen, and patient shall remain unchanged, and each subsequent picture be taken in the same manner. I have rendered the screen more useful by indicating the central cross-section by a knot or two oblique threads. This point being placed exactly opposite the sixth dorsal vertebra, or on a corresponding point of the front of the body, to be located with the spirit-level. It is

also advisable to mark upon the body with a skin pencil the spinous processes of the scapula, the spinous processes including the natal cleft, and to draw a line between the posterior spinous processes. The intersections of this line with the line marking the spinous processes will make a cross which will enable the eye clearly to note any deviation of the pelvis.

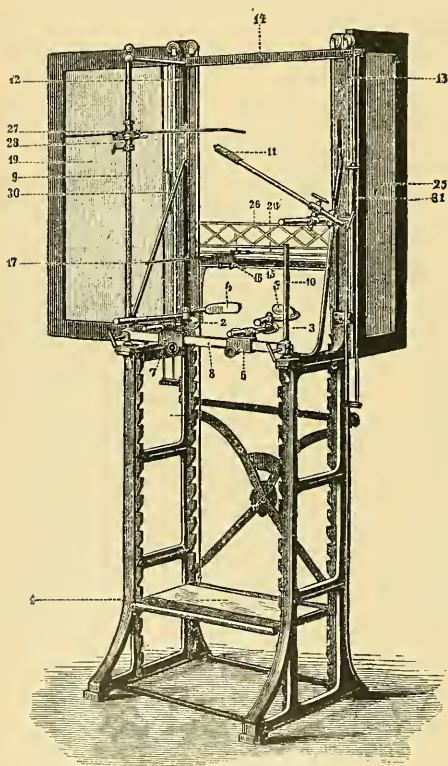


FIG. 398 — SCOLIOSOMETER OF SCHULTHESS.

Spellissy has proposed a uniform photographic method which, if adopted, would be of great service in providing practically identical conditions for all who are engaged in this work. He has recommended the use of a double print, taking as a standard for the squares one twenty-fourth of the stature, which is a convenient size both for record and comparison. This standard of measurement could be secured if those interested in the subject could agree upon the following:

“1. A standard focal length of lens;

“2. A standard focus and distance of subject from lens front;

“3. A standard direction of lighting for recording purposes;

“4. A standard size of image and of division of chart for comparative illustrations; and

“5. A standard series of poses in faulty habitual and also in corrected postures, standing, recumbent, and suspended; then the records of different observers would permit accurate comparison.”

3. **Bradford's Scoliosometer.**—This instrument is the most accurate

device for measuring for the degree of the deformity due to rotation of the bodies of the vertebra. It consists of two arms, a scale, and a spirit-level. It is placed on the body with the two arms together, and the rod containing the

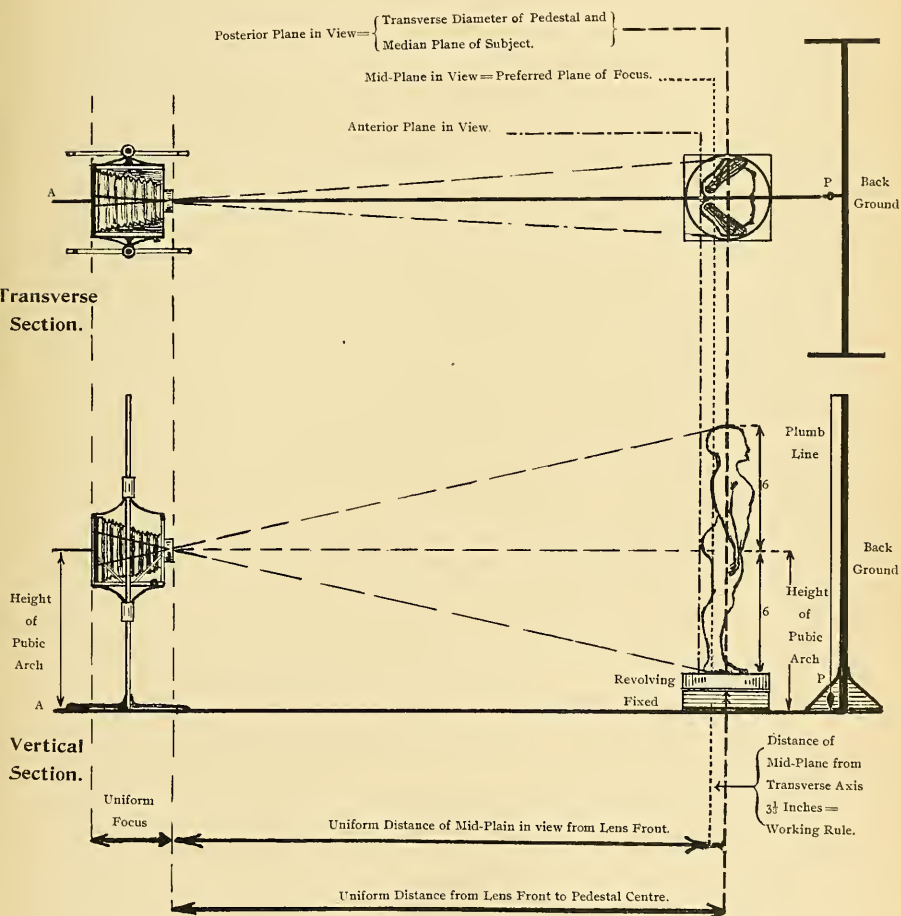


FIG. 399.—UNIFORM PHOTOGRAPHIC METHOD (Spellissy).

spirit-level is elevated until the horizontal is reached, when the degree may be read off.

4. **The Improved Trolley Delineator.**—This is an improvement on the

Weigel machine, and is so arranged that the outlines may be taken in the vertical and horizontal planes. The paper is on a continuous roll, and the tracing may be taken either with a wheel or a point. In either case the personal element enters into the taking of outlines.

5. **Rod Scoliosometer.**—This method is not unlike the scoliosometer of Beely, but it has one advantage, in that it is attached to an upright. Two points upon the spine, the seventh cervical vertebra and the top of the coccyx, are fixed against two rods of the machine, against which the patient leans. The rods are pushed in singly and marked upon the chart. Any deviation is indicated upon the chart which has square tracings upon it.

For the complete bibliography of scoliosometry see Hovorka, "Mittheilungen der anthropologischen Gesellschaft," Wien, 1904, Bd. xxxiv.

The three stages or degrees of deformity should be carefully separated, as these bear directly upon the prognosis.

In the first degree, *the curvature can be readily restored* by suspension, lying, or slight manual pressure.

In the second degree, *the curvature cannot be entirely restored* by these measures.

In the third degree, *the curvature cannot be affected in the least* by these measures.

In this connection, particular attention should be directed to those cases of so-called lateral *bending* of the spine occurring in all classes and conditions of youth from general debility, in which the spine, though much deformed laterally, is without rotation of the bodies of the vertebrae, and can usually be restored by effort of the patient, who is quickly relieved by attention to the general health. Lateral deviation of the spine occurring in Pott's disease may be confusing in the early stage. From Pott's disease of the spine the differential diagnosis will be found under the appropriate section.

Diagnosis in Individual Forms.—Every case of lateral curvature requires individual study, as no two cases are exactly alike. The diagnosis of the individual forms is also important and should be made at this time. The most common of all and the most easily recognized will be the habit scoliosis. Very frequently children suffering from this form of lateral curvature stand in an attitude which is characteristic and which may be readily recognized. The patient stands upon one foot with the other limb slightly flexed and thrust forward. The lateral curvatures which are due to rickets, but which rarely

occur, however, may be recognized from the association of other symptoms characteristic of the rachitic condition.

Lateral curvature due to empyema may frequently be recognized by the inspection of the chest, but the previous history will be of great service in distinguishing this condition from similar conditions due to paralysis. The physical signs in the chest will be of great service also in determining the condition of the lungs and pleuræ, and should have direct bearing upon the treatment.

The paralytic forms of lateral curvature are very frequently due to infantile spinal palsy. These are usually produced in two ways—first, from the paralysis of the muscles of the back, and also from the paralysis of one lower extremity, producing the static condition.

Traumatism as a cause for lateral curvature is very unusual, but I have occasionally seen patients suffering from lateral curvature resulting from a severe injury of the attachment of the ribs to the vertebrae which gradually developed into a dorsal scoliosis associated with kyphosis due to Pott's disease.

Lateral curvature from neuromuscular changes—scoliosis neuromuscularia ischiadica—should be diagnosed as early as possible. The history of exposure to sudden extreme ranges of temperature; the attitude of the patient with the entire body inclined to one side; the sciatic pain and muscular tenderness over the concavity of the spine, the gluteal region, and extending down the limb, are all characteristic of the acute affection. The later diagnosis will be more difficult, but assistance will be rendered through the previous history of the case.

Differential Diagnosis.—The two affections with which lateral curvature is most frequently confounded are lateral bending of the spine and lateral deviation of the spinous processes. Lateral bending of the spine is a very common condition in youth, and is due to general relaxation. The spine is deformed laterally but without rotation of the bodies of the vertebrae. The bending can be readily overcome by pressure with the hand or by the voluntary effort of the individual, and may be very soon recovered from by the administration of tonics and the use of massage. This differs from the first degree of lateral curvature, with which it might be confounded, in this respect, that no changes have yet occurred in the intervertebral disks.

Lateral deviation of the spinous processes occurs in Pott's disease during the exacerbation, the deformity being produced by unilateral muscular spasm.

The deviation is limited to a very few vertebrae in the region of the kyphosis. It passes very quickly when the patient is confined in the prone position, and should not be confounded with lateral curvature on account of the pressure of the kyphosis and the other symptoms characteristic of Pott's disease.

Another affection with which lateral curvature is very frequently confounded is Pott's disease itself. If the characteristic symptoms of this disease are carefully studied, error in the diagnosis will very rarely occur. The most important characteristic is the posterior deformity, which is in the median line of the body, is sharply angular in character, and is not affected by suspension.

In rickets of the spine the deformity is usually a posterior one, the curve is very long, is in the median line, and other symptoms of rickets are present in the individual.

In sacro-iliac disease the attitude of the patient might lead to an error in the diagnosis, the body being held to one side; but the pain, swelling, and other inflammatory symptoms in the region of this joint would quickly lead to a correct diagnosis of the condition.

In lumbago and sciatica the acute nature of the affection, the prominence of pain as a symptom, and the absence of a marked curve, would readily distinguish this condition.

Sarcoma of the spine would not at first be considered an affection which might be confounded with lateral curvature of the spine, and yet the writer has observed cases of persons past middle life suffering from severe lateral curvature in the lumbar region and accompanied by intense pain, which for some time appeared to be a malignant affection, but which was later found to be a lateral curvature of the spine.

Progress and Prognosis.

The progress, unless early arrested, is usually unfavorable; but the affection may be spontaneously arrested or become stationary at any stage. In the first degree, persistent and well-directed measures will permanently and surely restore the symmetry; in the second, the affection may with a degree of certainty be arrested, and, especially in primary lumbar scoliosis, be much improved, or even cured; but in the third stage nothing can be accomplished toward restoring the function of the spinal column, and measures must be directed to concealment of the deformity.

It has been asserted, but without positive proof, that scoliotic patients are

short-lived—heart lesions and apoplexy being, according to Bouvier, the most frequent causes of death. The dangers of parturition in scoliotic women are unfounded, except when the degree is of the highest grade, or rachitic deformity of the pelvis coexists.

Prophylaxis.

It is important that the attitude in sitting should be correct, since so many deformities of the spine are the result of faulty attitudes assumed in the sitting position.

The history of reform in school furniture in this country dates back to 1848, when Barnard published an article upon "School Architecture"; and abroad it was even later, 1865, when Fahrner, of Zurich, gave the result of his studies in "Das Kind und der Schultisch." The anatomic and physiologic factors were worked out by Meyer, of Zurich, two years later, and about the same time Cohn discussed the subject from the eye specialist's point of view. Staffel, 1884, Schenk, 1886, Lorenz, 1888, and, more recently, Schulthess, have made valuable additions to the literature upon this subject, all of them, for the most part, considering the problem of back-rests as a factor of importance in the production of lateral curvature. But the Germans have been much hampered by clinging to wooden benches for two or more, instead of individual seats of iron or wood.

It is now a generally admitted fact that badly designed school furniture is frequently the cause of round shoulders, spinal curvature, and short-sightedness; and in the effort to remedy this evil there have been probably 150 different styles devised.

What is known as the "balanced sitting position" with the feet resting firmly upon the floor and the knees bent at right angles with the body, is the one which school furniture should be designed to maintain. This means that the weight in sitting is balanced on the ischial tuberosities. To keep the body in this position as nearly as possible requires (1) a suitable and convenient height of the desk, (2) a support for the lower part of the back in writing as well as in reading, (3) proper height from the floor, and (4) proper distance between the desk and the edge of the seat. The support for the lower part of the back is especially important, as it brings out the normal physiologic curves. This support may be continued up to the *lowest* point of the shoulder-blades, or a separate upper back-rest may be used.

A great deal has been written about positive, negative, and nil distance

between a vertical line dropped from the edge of the desk and the edge of the seat, the positive distance meaning that the edge of the seat is behind the vertical line, the negative distance meaning that the edge of the seat is in front of the vertical line, and the nil distance meaning that the edge of the seat exactly meets the vertical line. It is important to understand these terms because the positive distance is generally considered to be the proper one for reading, and the negative distance for writing.

Certain definite rules, some general, some relative to the individual, may be given, as compiled from various authorities, as follows:

1. (a) The height of the seat shall be the distance of the bend of the under side of the knee from the floor.

(b) The width of the seat shall be a trifle wider than the buttocks.

(c) The length of the seat shall be two-thirds the length of the thigh.

(d) The seat should slope slightly down and back about three-eighths of an inch.

2. (a) The back-rest should be at an angle of 100 to 110 degrees with the seat.

(b) The back-rest should give especial support to the lower part of the back, about the region of the third or fourth lumbar vertebrae.

3. (a) The height of the desk above the seat should be equal to the distance from the olecranon of the bent arm to the seat, with two inches added, or one-eighth the height of a girl and one-seventh the height of a boy.

(b) The slope of the desk should be about 15 degrees for writing and 30 degrees for reading.

As may be readily seen, all these conditions cannot be fulfilled by fixed, immovable desks and chairs, and we therefore now come to the consideration of adjustable furniture. Dr. Cotton, of Boston, who has investigated this subject of school furniture at the request of the Board of Schoolhouse Commissioners, gives the following requirements of adjustable furniture:

1. Adjustment for height—vertically—of chair.
2. Adjustment for height—vertically—of desk.
3. A back-rest of proper inclination with an adequate support for the lower part of the back.
4. A proper depth of seat.
5. A proper slope of seat.
6. An adjustment of desk or chair for plus or minus distance—positive or negative.

The Miller chair was the one which best met these requirements until Cotton's experiments produced the desk and chair now used in certain Boston school-rooms. The essential features of the Miller chair are adjustment of the seat back for slope, with a spring attachment, and the rocking double back-rest. Cotton's model, which has been used with great satisfaction, consists of a curved back of wood, $9\frac{3}{4}$ inches wide and 5 inches high, with a concavity of

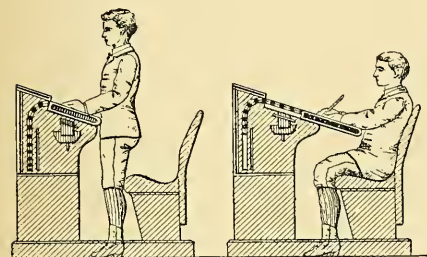


FIG. 400.—SCHOOL SEAT OF E. KÜFFEL.

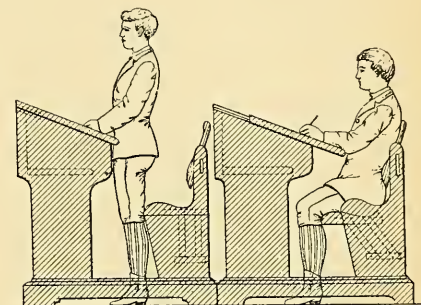


FIG. 401.—SCHOOL SEAT OF SCHREIBER AND KLINE.

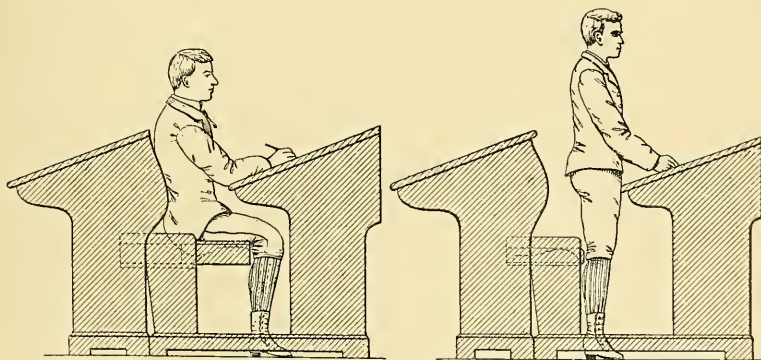


FIG. 402.—SCHOOL SEAT OF WACKENRODER.

1 inch from side to side and a convexity of 1 inch in profile. About one-third the way up is the greatest convexity, which when adjusted comes about opposite the fourth lumbar vertebra. Two sizes of these seats have been manufactured, some of them adjustable also for plus and minus distance, but this last feature is not so satisfactory as the others.

After the new furniture is installed the first adjustment is made by a scale

and by certain definite rules, but there are always some pupils who cannot be fitted in this way, and for these an individual adjustment is made by an expert.

The problem of varying the distance to the positive, negative, or nil, is a vexed one, and one which is more difficult in practice than in theory. Various methods have been devised for securing this distance, for example, the sliding desk top of E. Küffel, Schenk, and Chandler, the folding desk top of Parow, Schlimp's desk top on parallelogram supports, the seat swinging on a vertical pin, of v. Esch, and the seat swinging on parallelogram supports, of Schreiber and Kline, also the sliding seat of Wackenroder. For use in private families the chair and desk devised by Clarke meet most of the requirements, but the fact of both being movable renders this device unsuitable for large classrooms.

The practical difficulty in the employment of furniture adjusted to distance is that it is either very expensive or is noisy in its operation, so that even when provided it is not often used.

Malposture as a cause of lateral curvature has been considered by Gould,* who ascribes it chiefly to the fact that the individual, in the effort to bring the writing field into a clearer line of vision with the "dominant" or right eye, "skews" the paper, tilts the head to the left, and bends the body to the left also. This bending of the head to the left causes a right cervical curve and is the primary factor in the production of the scoliosis, the curves resulting in the right dorsal and left lumbar regions being secondary and compensatory. Any habitual torsion or rotation of the head will cause a corresponding torsion of the body, and if the line of vision be defective the effort to correct this will produce a spinal curve. The "head-tilting" is due more to an endeavor to bring the predominant 90 degrees and 180 degrees of astigmatism into a proper line of vision with the writing field, resulting, from the tilting of the head and body to the left, in a synchronous rotation of the head and body to the right. The preponderance of cases of lateral curvature among persons who habitually tilt the head to one side from astigmatism is noticeable, and as an etiologic factor this condition should receive careful consideration. The correction of the astigmatism, together with the adjustment of the paper so that the "dominant" eye has a clear field of vision, placing it preferably at an angle of 30 degrees, and 12 to 14 inches from the eye, the head and body being held in the

* "Journal of the American Medical Association," April 22, 1905.

normally erect position, will overcome the prevailing tendency to scoliosis among school-children. The production of torticollis from the effort to correct hyperphoria has been referred to under that subject.

Gould mentions the fact that among the Orientals the custom of beginning the writing at the upper right-hand corner of the paper, and carrying the lines from right to left, and the habit of many Japanese and Chinese of holding the paper in the air in the left hand at an angle of from 30 to 50 degrees, form a notable contrast to the methods in use among our own and European schools. This Oriental custom would give the desired result of a perfectly erect and hygienic position in writing.

Malpostures as induced by deficient light in school-rooms has been investigated by Abbott,* and it was observed that in the majority of instances where the light falling on the desk was poor, the pupil would habitually assume a faulty and deforming position in order to secure as much light as possible upon the paper or book. That the deficient light may be considered as an etiologic factor is emphasized by the fact that two pupils in changing desks would change their postures, each one assuming the position permitting the greatest amount of light to reach his work.

Where a pupil was occasionally permitted to change his seat, the faulty attitude did not become permanent; but where the same position was maintained from day to day, continuously throughout the school session, many of the pupils, 50 per cent., were found to assume habitual faulty attitudes at all times, both in standing and sitting.

Treatment.

This should be directed to the removal of the cause, the restoration of the health and strength, and the correction of the deformity.

The equalization of the extremities, change of occupation, assumption of a proper sitting position or carriage, and the administration of remedies for the correction of constitutional vice, such as preparations of cod-liver oil, iron, iodine, phosphates, etc., will all be useful in accomplishing a cure.

To correct or restore the deformity, properly directed gymnastic exercises are the most potent agents at our command. To assure a cure, the patient must devote herself (or himself) assiduously and persistently to the task for a long period. Self-suspension with a Sayre apparatus, double bar, horizontal bar,

* "American Physical Education Review," March, 1905.

trapeze, or rings, should be frequently practised during the day, alternated with periods of recumbency. In using self-suspension the rope should never be tied, as any accident, such as syncope, might result fatally. In all of these exercises, where possible, the hand on the concave side should be uppermost. While in the prone position, a hard curled-hair pillow, a bag of sand, or an air-cushion should be placed beneath the convexity, or Wolf's suspensory cradle employed.

The treatment of the deformity in lateral curvature should be divided into

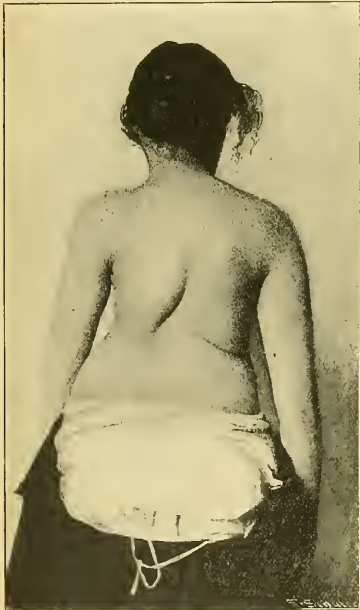


FIG. 403.—RIGHT DORSAL SCOLIOSIS (Hoffa).



FIG. 404.—SAME, SELF-CORRECTION (Hoffa).

three groups according to the degree. The first group, or the mild form, should be treated by gymnastic exercises with the use of a light support in selected cases. The second, or medium form, should be treated by forcible manual or mechanical correction and the use of suitable exercises, corrective movements, and forcible manipulations. The third, or severe form, is not amenable to treatment, except that, by means of suitable exercises and forcible correction, relief may be obtained for the pressure pains, but the deformity will have to be concealed as

much as possible by suitable clothing, and everything should be done to make it as inconspicuous as possible.

The treatment which I have found most satisfactory in the first group of cases consists in the use of light gymnastics, and may be divided into four parts:



FIG. 405.—HABITUAL POSITION. SCOLIOSIS.



FIG. 406.—SAME, GOOD CORRECTION BY SUSPENSION (Cohen).



FIG. 407.—CORRECTION FOR SCOLIOSIS. ARM EXTENSION WITH BELLS. INCORRECT POSITION.



FIG. 408.—SAME, CORRECT POSITION.

(1) the development of the weak muscles by exercises adapted to them individually or collectively, (2) the slight over-development of the weak muscles, (3) the development of all the muscles, and (4) the use of certain exercises to prevent relapse. The exercises in each instance will have to be selected according

to the locality of the curve, and as primary curves are exceedingly rare, combinations of the exercises for the treatment of curves in different parts of the body will have to be employed. Some persons are not able at first to take such exercises as are required for the correction of the particular curve, and in these instances it is necessary to begin with a few general movements which may be taken in the recumbent position. The patient, lying upon the back, may take head rotation, arm rotation, and leg rotation, with breathing exercises, until



FIG. 409.—SUSPENSION CORRECTION FOR SCOLIOSIS.
A, Usual position; B, moderate correction; C, best correction.

sufficient control of the muscles has been gained so that the special exercises may be taken up. Series of exercises may be used to treat the special curves, the exercises which are found most useful being given. Before beginning the exercises the best voluntary position, known as the best standing position, which the patient can assume should be determined, and this should be returned to after each corrective exercise has been taken.

The first exercise will usually consist in taking the position which best corrects the deformity, and known as the keynote position. There are many

keynote positions, the arms being placed at different angles; for example, the keynote position for right dorsal scoliosis, the most common form, is with the right arm extended sideways, and the left arm extended upward.

This keynote position places the muscles in the best possible relation for exercising. The use of the spiral movements, such as the keynote, forward sideways turning, have been found to be very beneficial, and the writer has not met any of the bad effects from these movements referred to by some writers. The studies of Lovett would seem to prove that the twisting and turning movements of the body might have the effect of correcting rotation of the bodies of the vertebrae. Special attention should always be paid to the development of the lower extremities, both because these are frequently unequally developed, and because it is necessary to have a firm base of support upon which to erect a straight superstructure.

In taking all these movements for the correction of the curvature, the greatest care should be exercised, and the patient should be constantly under the observation of the surgeon. The tendency of surgeons to relegate the treatment of lateral curvature to trained assistants is to be condemned, and the preference should be given to treatment by trained assistants under the daily supervision of the surgeon.

The treatment should be given daily for periods of from three to six months, preferably the latter, and the tendency to insert new exercises from time to time in order to please the individuals is not to be recommended. A certain amount of variety may be permitted, but it is better occasionally to change the exercises, returning frequently to those which are found to be the most beneficial, or, better still, to continue those which are the most useful, supplementing these from time to time with others.

The use of massage after the exercises have been taken is a subject which is deserving of some consideration. The writer is of the opinion that patients do better who have daily massage after their exercises than those who do not. The massage should consist of several different movements intended to improve the weaker muscles, to divert the blood from the spinal column, and to rest the patient after the exercises.

The exercises should be taken daily except Sundays. During the menstrual period the exercises should be omitted entirely for a day or two, and the hip and hanging movements should be discontinued until the cessation of the flow. During the summer the exercises may be modified, and in many instances

it is best to discontinue them altogether, depending upon the outdoor life of the individuals for the necessary exercise.

Patients who are being treated for lateral curvature should not be permitted to attend school, since school life not only fatigues but interferes with the proper amount of rest required by the individual. Patients should not be permitted to go out in society, nor be encumbered with social engagements of any kind. The morning of each day should be devoted to the treatment, and at least two hours in the afternoon should be spent in the prone position. Late hours should be

avoided, and evening entertainments should be interdicted. All games which employ one side of the body more than the other should be forbidden. And the possibility of the one-sided games producing lateral curvature should not be forgotten. The writer has met individuals otherwise very well developed who were deformed from playing ball to an unusual degree.

The breathing should be carefully regulated during the taking of the exercises, and at the end of each movement one or two full inspirations should be slowly taken.

Particular attention should be paid to the muscles upon the convexity of the curve, as these are the weaker muscles. In carrying out the treatment the skeleton is placed in such a position that the muscular attachments assume a more normal position and can therefore be developed



FIG. 410.—BEST STANDING POSITION

through their proper contraction and relaxation. No series of exercises can be followed arbitrarily, but the special exercises required in each individual case should be prescribed by the surgeon.

The special exercises used in right dorsal scoliosis are as follows:

1. Best standing position.—This corresponds to the standing fundamental position described in all standard works upon Swedish gymnastics.

• 2. Keynote position.—In this position the arms are slowly raised shoulder high and the left arm is gradually carried straight upward in extreme extension



FIG. 411.—KEYNOTE POSITION.



FIG. 412.—KEYNOTE—SIDEWAYS BENDING TO RIGHT.



FIG. 413.—KEYNOTE—FORWARD SIDEWAYS TURNING.

with the hands in the frontal plane and the palms turned directly forward. The arm is then slowly lowered until it is shoulder high, and both arms are then lowered until the fundamental standing position is reached.

3. Keynote, forward bending.—The patient assumes the keynote position, the body is carried slowly forward by flexion in the hip-joints until the stoop standing position is reached. The knee-joints are in full extension, the head bent slightly backward, and the gaze directed forward. From this position the patient returns gradually to the keynote and fundamental standing positions.



FIG. 414.—KEYNOTE—KNEE-BENDING, TOE-STANDING.



FIG. 415.—KEYNOTE—FALL OUT, STANDING.

4. Keynote, sideways bending, to right.—The keynote position is assumed and the patient slowly bends the whole spine to the right, keeping the shoulders and hips in the sagittal plane, until the body assumes the side-bend-standing position. The patient then gradually returns to the keynote and fundamental standing positions.

5. Keynote, forward sideways turning.—The keynote position is assumed, and the patient combines the twist-standing with the stoop-standing positions until an extreme combination of these two positions is reached, care being taken

not to alter the position of the feet. The patient then returns to the keynote and fundamental standing positions.

6. Keynote, heels rising.—The patient assumes the keynote position, and then gradually raises the body until the weight rests entirely upon the balls of the toes, and from this position returns slowly to the keynote and fundamental standing positions.

7. Keynote, knee-bending, toe-standing.—The patient assumes the keynote position and gradually raises the body from this position by raising the



FIG. 416.—HANGING—RIGHT LEG RAISE WITH RESISTANCE.



FIG. 417.—HANGING—KNEES ABDUCTING WITH RESISTANCE.

heels, combined with bending the knees, and then gradually returns to the keynote and fundamental standing positions.

8. Keynote, fall out standing.—The patient assumes the keynote position and then moves the right leg forward at an angle of 60 degrees three foot lengths, at the same time bending the right knee and keeping the other knee in full extension, while the trunk is carried over the bent knee. This position is maintained for ten seconds, after which the patient gradually returns to the keynote and fundamental standing positions.

9. Hanging, right leg raise with resistance.—The patient standing beneath the boom, which is inclined with the left end four inches higher than the right, or else beneath rings, the left one of which is three inches higher than the right, takes hold of the boom or rings with the hands separated the width of the shoulders, and suspends the body in such a manner that the feet swing clear of the floor. The right knee is slowly flexed forward, resistance being made by the attendant.

10. Hanging, knees abduct with resistance.—The patient takes the same hanging position as in No. 9 and abducts the knees, the attendant resisting.

11. Hanging, knees adduct with resistance.—The patient assumes the same



FIG. 418.—PRONE. KEYNOTE—BACKWARD SIDWAYS TURN.

hanging position as in No. 9 and slowly adducts the knees, the attendant resisting.

12. Supine, right hip flex with resistance.—The patient assumes the lying fundamental position and flexes the right knee and hip, the attendant resisting.

13. Supine, right hip extend with resistance.—The patient, in the lying fundamental position, flexes the right knee and hip, after which the knee and hip are extended, the attendant resisting.

14. Supine, right hip rotate with resistance.—The patient assumes the lying fundamental position and the attendant rotates the hip with resistance.

15. Prone, keynote, backward sideways turn.—The patient lies upon the table, face downward, and slowly raises the arms to the keynote position. The limbs are firmly held by the attendant or are strapped into position, and the

patient bends the body backward and to the right. The efficiency of this movement may be increased by the patient assuming the stretch forward lying position, the limbs being strapped into place, and the attendant supporting the patient's arms.

16. The patient assumes the same position as in No. 15, and swimming movements may be taken. Or this position may be assumed, the body of the patient extending over the end of the table, in the leg forward lying position, the movements may be taken, with resistance by the attendant.



FIG. 419.—SALUTE.



FIG. 420.—HIPS FIRM, RIDE SITTING, TRUNK ALTERNATE TWISTING.

17. Salute.—The patient assumes the fundamental standing position, flexes the right forearm, carries the arm upward shoulder high, and slowly stretches it outward on a level with the horizontal plane of the shoulders, keeping the hand with the palm turned downward, after which the fundamental standing position is again gradually assumed.

18. Hips firm, ride sitting, trunk alternate twisting.—The patient sits astride on the plinth with the pelvis and legs fixed, the attendant standing behind the patient and placing her left hand beneath the left shoulder slowly lifts it,

at the same time depressing the right scapula with her right hand, after which the left shoulder and right scapula are allowed to return slowly to the original position. Exercises Nos. 3, 4, and 5 can be given with great advantage on the plinth, as may also the swimming movements.

Exercises Nos. 3, 4, and 5 may also be given with advantage in the leg lean standing position; that is, with the patient resting the front part of the thighs against the boom.

It will be noted that in these exercises for right dorsal scoliosis there are



FIG. 421.—EXERCISE ON PLINTH. KEYNOTE POSITION.



FIG. 422.—EXERCISE ON PLINTH. ARMS EXTEND, FORWARD BEND.

certain movements given for the correction of left lumbar scoliosis which is sometimes secondary to the right dorsal scoliosis.

The photographs illustrating the special exercises for the first group of cases are taken from a model. Patients when taking these exercises wear a special gown which exposes only the back.

The inequality of the lower extremities must be corrected. For example, the right or long limb in right dorsal scoliosis must be contracted by the fall-out standing position, No. 8, and by the other special exercises, Nos. 9 to 14, inclu-

sive, which tend to shorten the muscles about the hip-joint. Traction can also be made upon the short limb.



FIG. 423.—SWIMMING MOVEMENTS (Berger and Banzet).

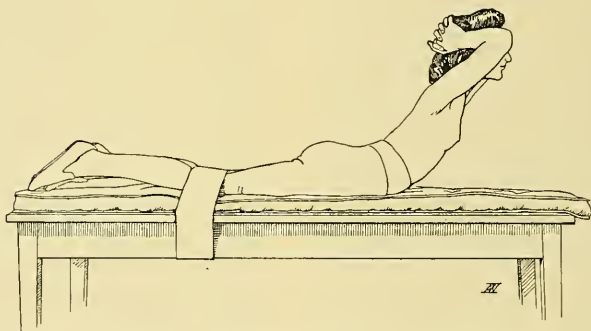


FIG. 424.—CORRECTED POSITION. TRUNK RAISED IN VENTRAL DECUBITUS (Berger and Banzet).

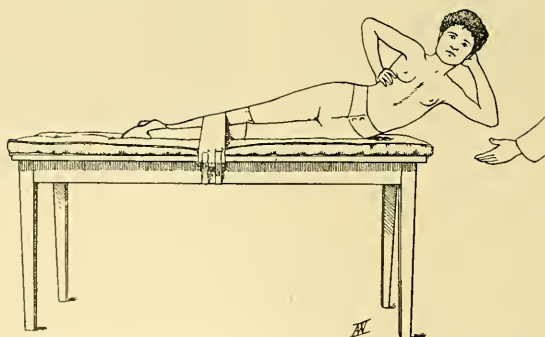


FIG. 425.—LATERAL CORRECTION. TRUNK IN PRONE LATERAL EXTENDED POSITION (Berger and Banzet).

The exercises for left dorsal scoliosis are the same as those for the right dorsal, with the positions of left and right exactly reversed.

Each of the foregoing exercises should be taken once a day, beginning with ten times each, and gradually increasing the number until twenty-five is reached, and in certain special exercises the number may be increased to fifty times.

Exercises on the plinth will be found of great value. The same exercises which have already been given to be taken in the standing position,—keynote

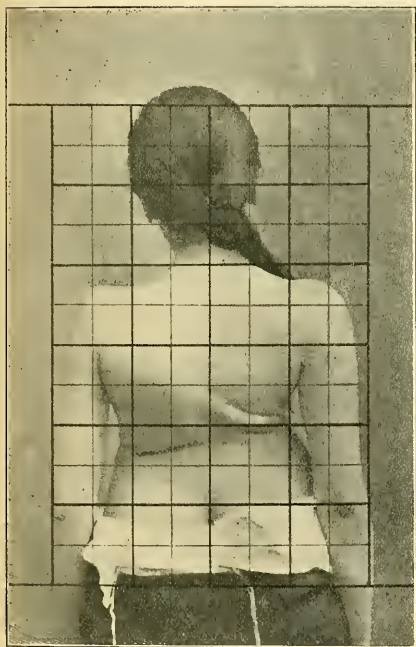


FIG. 426.—SEVERE SCOLIOSIS. BEFORE TREATMENT (Hovorka).

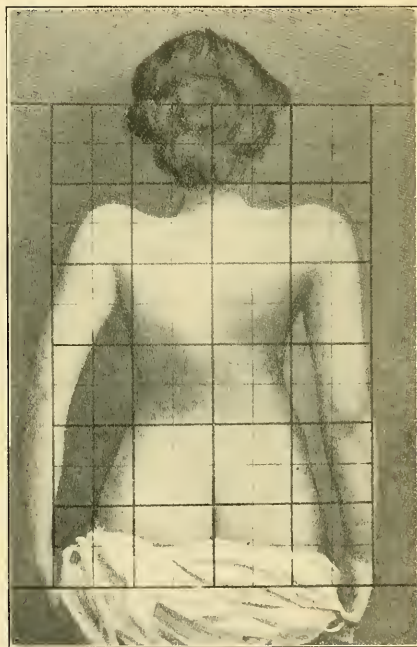


FIG. 427.—SAME, AFTER TREATMENT (Hovorka).

forward bending, keynote sideways bending to the right, and keynote forward sideways turning, and also the swimming movements may be taken while sitting with the limbs strapped to the plinth; the advantage of exercises taken in this position is that the pelvis is fixed.

Other exercises may be taken in the prone position upon a table or couch. Lying upon the face, swimming movements may be taken. Lying upon the face with the feet fixed, the trunk may be raised to the corrected position; and

lying upon the face with the feet fixed and the right hand resting upon the prominent ribs, the trunk may be raised to a lateral position.

Where the lumbar scoliosis is primary, additional exercises are given for the correction of this curve. These should consist principally of the hanging movements with flexion, extension, and circumduction of the hip. In the left lumbar scoliosis which occurs as a secondary condition to right dorsal scoliosis the right hip should be flexed, rotated, and circumducted. The entire right

limb is held firm by fixation of the knee-joint and ankle-joint, and is raised by the patient, the attendant resisting downward by holding the foot.

In the treatment of primary cervical curves special exercises should be given to develop the convex side of the curve. The patient being in the side sitting position on the plinth, the head is carried toward the convex side with resistance.

The patient, in the supine position, should also take head movements consisting of flexion, extension, and circumduction, with the head and neck extending over the end of the table and the arms placed alongside of the body with the palms turned upward, resistance being made by the attendant.

After the deformity has been corrected by these various exercises they should be continued until slight overdevelopment of the weak muscles has



FIG. 428.—SHAFFER SPINE BRACE APPLIED TO CASE OF LEFT DORSAL SCLIOSIS.

been attained, after which the keynote position should be abandoned, and exercises substituted with both arms extended shoulder high, with both arms elevated, or with the arms in the neck rest position. With these positions as fundamental, standing position exercises Nos. 3, 4, 5, 6, 7, and 8 should be given and the other exercises given as before. In this manner the general muscular development will be accomplished, and after the patient has been dismissed this general development may be continued by the use of certain exercises as published by Dr. Keating and myself,* as follows:

* Keating's "Cyclopedia of the Diseases of Children," vol. iv.

- "1. Neck rest standing, heel rising.
- "2. Neck rest standing, trunk change turning.
- "3. Stretch standing, trunk sideways bending.
- "4. Stretch stride standing, trunk forward bending.
- "5. Half stretch walk, standing position.
- "6. Stretch walk standing, trunk turning position.
- "7. Yard walk, fall standing position.
- "8. Stretch standing, heels rising, knee bending."

The use of bilateral exercises has been recommended by some surgeons. When these are employed, they do not differ materially from the gymnastic exercises for general developmental work, except that greater attention is paid to the correctness of posture and the precision with which the work is done.

There has also been a tendency to introduce the use of heavy gymnastics. As employed by Teschner, these represent muscular development as taught by Attila, the trainer of Sandow. This method consists essentially in the systematic cultivation of all the muscles of the body in addition to those which are particularly affected. It insists upon the muscular effort being carried to the point of fatigue, the work being increased from day to day, and the course being a rapid one. It includes systematic exercises with light dumb-bells followed by the use of heavy weights, principally steel bars and bar bells weighing from 26 to 72 pounds. The effort required to lift the heavy weights has a tendency to straighten the spine, and the method has been used with advantage in cases of general lack of development of the muscles of the back. This method requires the same personal attention and the same precision in its use as in the employment of the light gymnastics already mentioned. It has been fully described and illustrated in the "Annals of Surgery" for August, 1895.

On account of the danger of overwork this system should only be employed under the personal direction of a physician.

After the first few lessons, the exercises become a pleasant pastime, and the rapid and constant improvement leads the ambitious on to the acquisition of a perfect figure, with a buoyancy and vigor of health before unknown. In the first group of cases braces are not necessary and should not be recommended, since

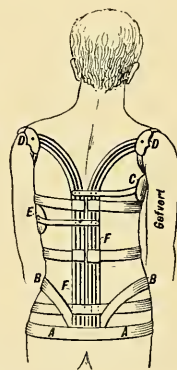


FIG. 429.—LATERAL CURVATURE BRACE.

the greatest dependence must be placed in properly selected exercises for the accomplishment of the cure.

Treatment of the Second Group of Cases.—In the treatment of the second group of cases of scoliosis the exercises already described will be of some service to render the curves more flexible, but resort must be had to the use of corrective apparatus of all kinds, manipulations, both manual and instrumental, and the use of orthopedic appliances. The gymnastic apparatus which will be found valuable include Swedish rods, boom, stall bars, high plinth and low plinth.

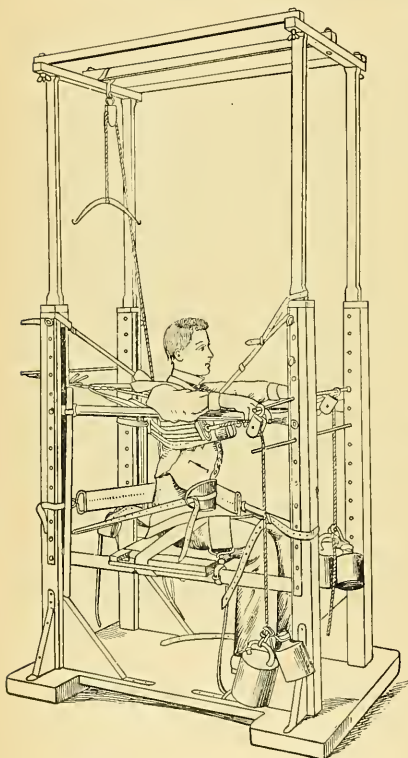


FIG. 430.—BEELY CORRECTING MACHINE FOR LATERAL CURVATURE.

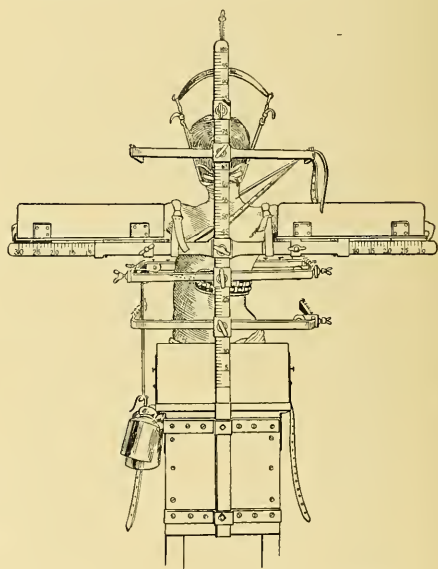


FIG. 431.—BEELY-RADIKI CORRECTING MACHINE.

Of the mechanical supports, I have found a modified Shaffer brace when well fitted to be a valuable accessory to treatment. (Fig. 428.) This consists of a well-fitted steel waist-band, with diverging steel pieces in front and back attached together with webbing; from this waist-band is built up a crutch under the depressed shoulder, and a pad over the deformity. Strong webbing

straps pass between the pad and the crutch in front and behind, and act laterally upon the prominence. The modifications made by the writer are a flattened axillary crutch after the pattern of Ernst, of London, and an increased number of straps of webbing below the band to insure greater stability. An apparatus of this character may be incorporated into a jean corset, or in some instances a neat fitting corset may be reinforced with light steels, with a padded crutch under the axilla of the low shoulder. It is, however, to be clearly understood that these appliances do not aim to correct the deformity by direct pressure, but are employed rather as a *reminder* to the patient to assume a correct posi-

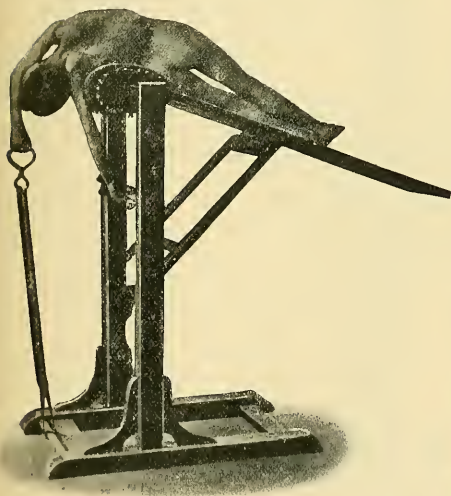


FIG. 432.—LATERAL SUSPENSION APPARATUS OF REDARD. SELF-CORRECTION.

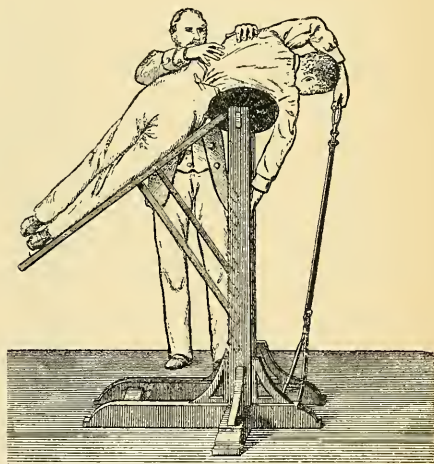


FIG. 433.—LATERAL SUSPENSION APPARATUS OF REDARD. MANUAL CORRECTION.

tion, and as a slight support to the body during the intervals of exercise and recumbency. Where a brace is desired to correct the deformity by continuous pressure upon the convex side, a heavier appliance with two steel pelvic bands, uprights, crutches, etc., will be required. Of such a pattern are the Redard, Gefnert, and all braces constructed upon the original Sheldrake model.

Mechanical Correction.—The corrective apparatus are for the most part constructed upon one of two principles, either gymnastic apparatus used as corrective machines or machines for the mechanical stretching of the contracted curves.

The first are represented by the movable inclined planes by which the patient is suspended and uses the body-weight to assist the correction, as in the Redard apparatus, where the patient lies upon a plane and the feet are gradually lowered to make the corrective pressure.

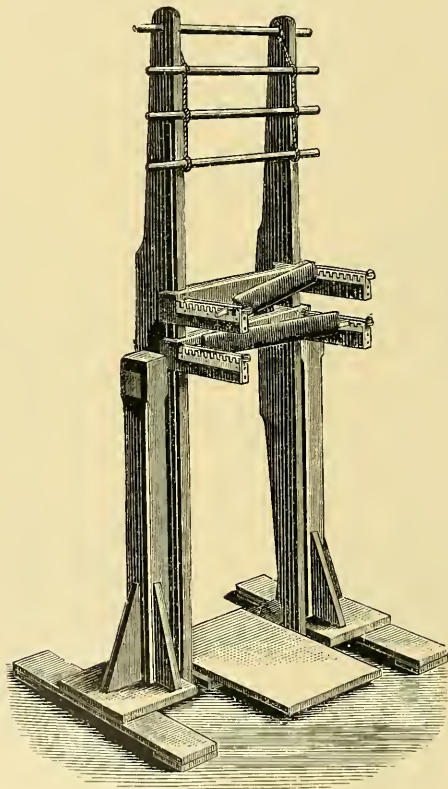


FIG. 434.—BEELY'S CORRECTING MACHINE FOR SCOLIOSIS.

The same principle is used in the Lorenz swing, where the patient hangs upon a frame and is gradually lifted off his feet by the movement of the frame. There are many others constructed upon the same pattern, and all are an exaggerated reproduction of the Shaw couch, so much employed sixty years ago.

Correcting Machines.—The mechanical correction of scoliosis has become popular only within the past decade. The principle of all is the same, and experience has shown how much force can be applied with advantage, and without injury.

Two forms of appliances are employed:

1. Those which place the trunk in corrective attitudes, and apply pressure

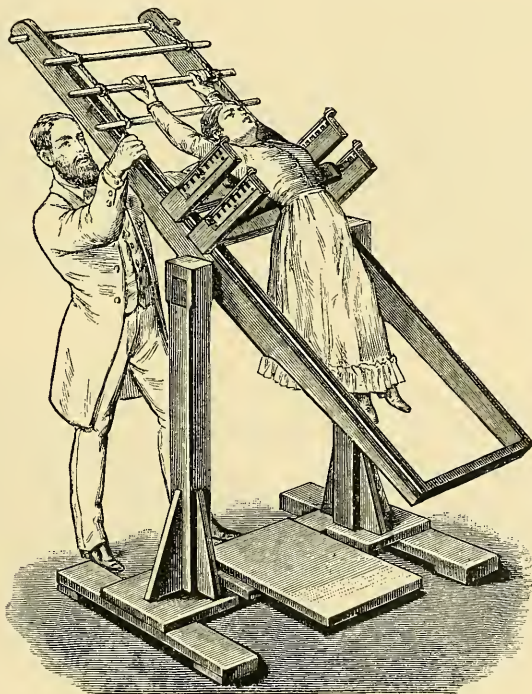


FIG. 435.—SAME APPLIED.

by means of bands or straps, with or without self-suspension. The best example of this form is that of Beely—a square framework in which the patient is placed and in which weights and straps act as correcting agents. This has been improved by Radike.

2. Those in which the principle of self-suspension is combined with pressure. The original example of Schede has been much improved by Hoffa,

has been modified by Bradford and Brackett, and has reached its highest perfection in the Weigel machine.

These machines are of the greatest value in the correction of the rotation which complicates the severe types. The patient remains in the machine for from ten to thirty minutes for one or two periods each day, wearing a correcting

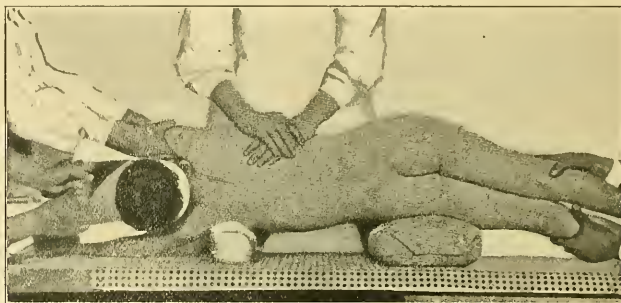


FIG. 436.—MANUAL CORRECTION OF SCOLIOSIS (Redard).

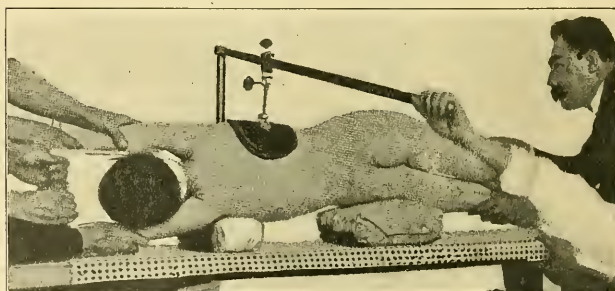


FIG. 437.—LEVER CORRECTION OF SCOLIOSIS (Redard).

brace or modeled plaster cast during the interval, and retaining the horizontal position for several hours daily.

When it is desired to maintain the correction, a plaster-of-Paris cast may be put on while the patient is in the machine. A better method is that of Redard. The patient is corrected in the horizontal position, and the pressure pad used for the correction is incorporated in the dressing.

Lovett employs an apparatus constructed by Adams which provides for the

independent or combined correction of both lateral curvature and rotation of the spine. Its description may best be taken from Lovett's article*:

"The apparatus consists of a heavy gas-pipe frame three by four feet. The patient lies face downward on two webbing strips running from end to end of the frame with the legs flexed. Near the bottom of the frame is an adjust-

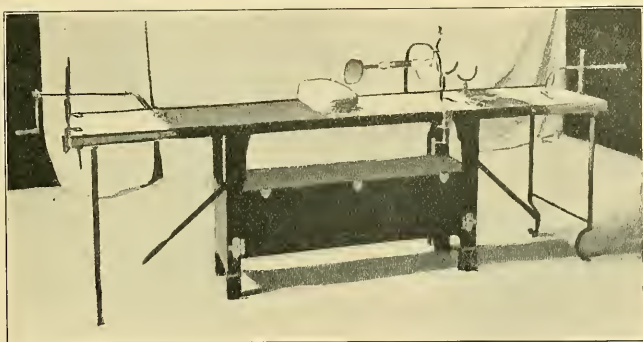


FIG. 438.—FRAME FOR FORCIBLE INSTRUMENTAL CORRECTION OF SCOLIOSIS (Redard).

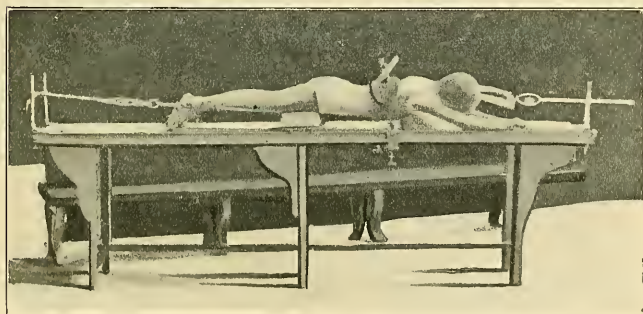


FIG. 439.—SAME, SHOWING PLASTERS APPLIED (Redard).

able crossbar bent to fit into the flexure between the thigh and the pelvis on which the patient rests the lower part of the body. Sliding on this bar are two arms which slide in and clamp down on the buttocks, holding the pelvis steady on the crossbar. This bar is movable from side to side in order to induce or cor-

* "Boston Medical and Surgical Journal," March 17, 1904.

rect curvature in the lumbar region when necessary. There are three vertical transverse rings two feet in diameter fastened to pieces on the sides of the frame so that they can be moved to any desired point along the frame. These rings are also movable from side to side, and by an independent movement they can



FIG. 440.—PATIENT BEFORE FORCIBLE CORRECTION (Redard).

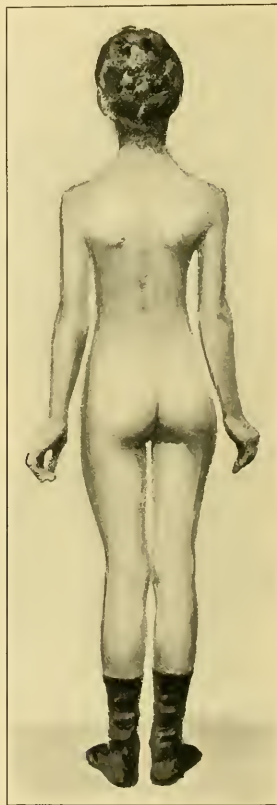


FIG. 441.—SAME, AFTER FORCIBLE CORRECTION (Redard).

also be rotated through a half circle. Any one of these movements can be checked at any point by turning a screw. The shoulders are held by a pair of axillary straps fastened together by a strap across the chest in front. These straps are suspended from the ring nearest to the top of the frame and can be

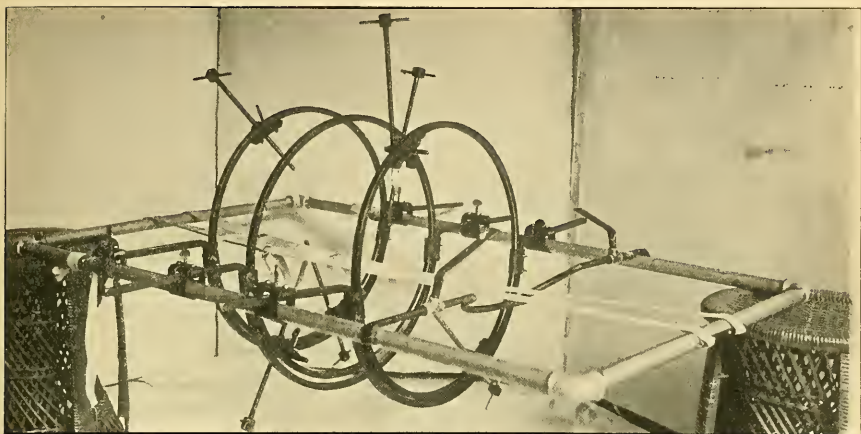


FIG. 442.—LOVETT CORRECTIVE APPARATUS

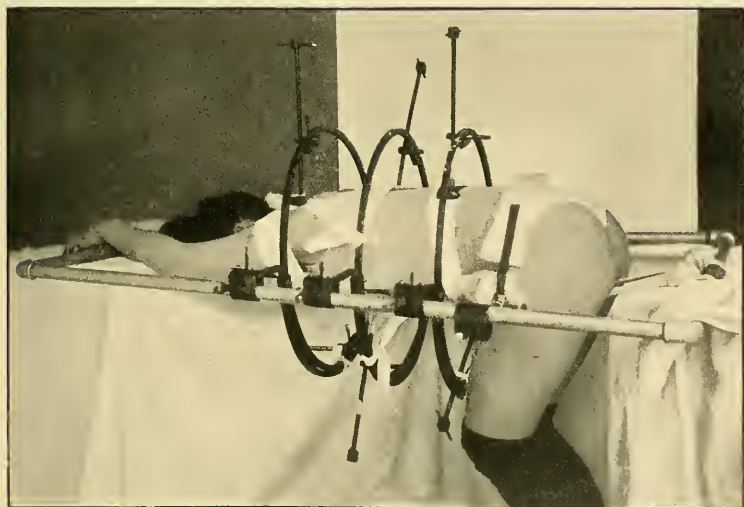


FIG. 443.—LOVETT CORRECTIVE APPARATUS. PATIENT IN POSITION.

made to hold the shoulders in any desired degree or twist by a rotation of the ring.

"Each ring is provided with two long screws at the two poles of the ring. These screws are adjustable upon the ring and can be set at any desired angle to it. By rotating the ring and adjusting the angle of the screws they can be made to screw down or up upon any part of the back or chest."

The patient is placed face downward on the two webbing strips with the buttocks fixed by the adjustable crossbar, the feet resting upon the floor, and the arms extended above the head. The shoulders are held by bandages attached to the upper ring and passing across the axilla, together with screw pressure up or down if necessary. The rings are then moved opposite to those places where it is desired to make correction.

Correction of lateral curvature is made by passing a broad bandage over a protective pad of felt on the patient's side, the cords of the bandage being fastened to the ring on the other side. Then by moving the entire ring laterally the bandage is tightened and any desired amount of corrective force may thus be applied. Correction of rotation is next made by rotating the ring until the screws are opposite the desired point, when they are screwed down upon the patient. The points of the screws are protected by pads of sheet-iron, two by three inches, faced with heavy felt to prevent injury to the patient.

A plaster-of-Paris cast or other retentive jacket is then applied in the corrected position and worn for a suitable length of time. Such a jacket would necessarily have to have the pads incorporated in it, as the corrective force is not removed until the retentive dressing is properly adjusted.

Third Group.—Much has been written of late about fixed and flexible curves, the former being included under the present group of cases, in which the curve is not at all influenced by self-suspension. The treatment should consist in a persistent effort to render the curves flexible by means of manipulations, exercises, and machines. If the curve is made more flexible, then these cases should be treated in the same manner as the second group, which has already been described. In all persons suffering from this degree of deformity pain is very constant and distressing, and this should be relieved by extension, self-suspension from a bar, the use of extension machines, breathing exercises, and the use of all means which will expand the chest and relieve the pressure of the ribs. The local application of anesthetics will be found beneficial, such as baum analgésique, mesotan ointment, 25 per cent., with petrolatum, or oil of betulol, etc. When the condition is extreme, relief may sometimes be obtained

for the excruciating pain by the excision of a rib, the writer having practised this with great satisfaction in selected cases.

Tenotomy, myotomy, and forcible restoration have been advocated from time to time, but have fallen into disuse. Operative interference undertaken with the object of removing the prominence by resection of ribs was suggested by Volkmann in 1889, and was twice performed by Hoffa in 1896.* An operation advocated by Shaffer† for the correction of rotating scoliosis has been performed upon the cadaver. More recently Hoke‡ has performed a carefully planned and successful operation consisting of the section of a number of ribs upon the prominence of the deformity. This operation was performed as a preliminary to correction by plaster-of-Paris jackets.

For the complete literature of lateral curvature see Arnd, "Archiv. Orthopaed., Mechan., u. Unfall," Bd. i, Heft ii, 1904.

* "Zeit. f. orth. Chir.," 1896, p. 401.

† "Am. Med. and Surg. Bulletin," Jan. 1, 1894; Feb. 15, 1894.

‡ "Amer. Jour. Orth. Surg.," vol. i, No. 2.

CHAPTER XVIII.

INFANTILE SPINAL PARALYSIS.

Infantile paralysis is an acute, more rarely a chronic, inflammatory affection of the large multipolar ganglion cells in the anterior cornua of the cord, characterized by a sudden loss of power of the voluntary muscles unaccompanied by any sensory changes, and resulting in atrophy in one or more muscles or groups of muscles with deformity.

Synonyms.—*English*, Infantile Paralysis; Infantile Spinal Paralysis; Essential Paralysis; Atrophic Paralysis; Paralysis during Dentition; Regressive Paralysis; Myelitis of the Anterior Horns; Tephromyelitis; Myogenic Paralysis; Poliomyelitis Anterior. *French*, Paralyse Infantile; Paralyse Spinale; Paralyse Atrophique Graisseuse de l'Enfance; Paralyse Essentielle; Tephromyélie Antérieure Aiguë. *German*, Kinderlähmung; Spinale Kinderlähmung. *Italian*, Poliomieliti; Paralisi atrofica dei bambrici; Mieliti anteriora. *Spanish*, Parálisis atrofica infantil.

Etiology.

Anterior poliomyelitis is usually considered to be peculiarly an affection of childhood and infancy, and hence is generally termed infantile spinal palsy—the name given it in 1840 by Heine. It was not until 1873 that the first adult case was described by Gombault, and three more by Bernhardt in 1874, two of which cases had paralysis of all four extremities. The mortality and severity of the disease would seem to be higher in adult cases. The differential diagnosis between Landry's paralysis and anterior poliomyelitis, and the neuroses and anterior poliomyelitis, would seem to be so difficult in the adult that in many cases the diagnosis cannot be made without pathologic corroboration. It is stated by Taylor that many so-called cases of Landry's palsy have been subsequently proved by postmortem findings to be anterior poliomyelitis. During his four years and three months' service at the Out-patient Department of the Massachusetts General Hospital 76 cases were diagnosed as adult anterior poliomyelitis, 10 of which were upward of twelve years and five of which were eighteen years and more. The relative frequency of the affection in childhood

may be inferred from the statement of Holmes Coote, that out of 1000 children in the Royal Orthopedic Hospital, 80, or 8 per cent., suffered from infantile palsy. It is said to be the most frequent spinal cord disease in children, an acute transverse myelitis rarely occurring before the tenth year, and then not so frequently as anterior poliomyelitis, and a disseminated or focal myelitis occurring sometimes in zymotic disease among children. As to the possibility of the intrauterine development of the paralysis, the writer believes, with Gowers, that there is as yet no valid evidence, and certain it is that most of the cases of congenital club-foot (equino-varus) are not, as some writers believe, the result of an intrauterine palsy. It may come on soon after birth, as in the case of Duchenne, which was attacked on the twelfth day, and that of Bramwell, which developed when the child was three weeks old, and also that of Schultze, which occurred in a baby of four weeks; but it is infrequent during the first year, being rare in the first six months. The great majority of cases occur between the ages of six months and three years; this being the period of primary dentition. There is, however, no proof of the relationship between dentition and the disease. Other factors in this relative frequency may be found in the fact that this period is also that during which children learn to walk, and hence, according to the theory of Ashby and Wright, overexert the leg muscles, producing a peripheral irritation, and also because during this time they are especially prone to exhausting digestive disturbances. It is probable, as remarked by Meigs and Pepper, that early age and dentition only act indirectly by inducing a remarkably susceptible condition of the entire spinal system. In this condition of exalted nervous irritability the spinal cord is especially susceptible to sudden changes in the surface temperature, as by a sudden cooling of the overheated surface. Statistics as to the relative frequency of anterior poliomyelitis during this period have been compiled by various observers; according to Gowers, of all the cases under ten years, three-fifths occur during the first two years and four-fifths during the first three years. Of 71 cases collected by Seeligmüller, 90 per cent. occurred before three years; of 70 cases collected by Galbraith, 55 occurred before the third year; of 350 cases collected by Sinkler, in 335 of which the age of the patient was noted at the onset of the attack, 247 occurred under three years, and the average age of the attack was two years, one month, and two and one-fifth days; and of 115 cases collected by Starr, 54 occurred before three years and 1 before the fourth year. In a tabulation of the cases collected by these five observers, Starr finds that 472 out of 609 cases, or 77 per cent., occur before the fourth year, 420, or 60 per

cent., before the third year. Of 83 cases collected by Schultze, there were 11 during the first year, 31 during the second year, and 3 over five years, and in 250 cases collected by Heine, Duchenne the younger, and Barlow, 154 were between six months and two years. One case occurred at sixty-three. Sex appears to have no influence whatever upon its production, although it is stated by some writers that boys are more frequently attacked than girls, especially after the tenth year. Of the 345 cases recorded by Sinkler, 184 were boys and 161 were girls, and of the 63 cases collected by Barlow, 33 were males and 30 were females. The disease appears also to be almost as frequent among the children of the wealthy as among those of the poor, and Buzzard thinks "it is more common than not for the disease to attack fine, grown, hearty children."

Heredity does not seem to have any influence, and cases in which more than one individual is affected in the same family appear usually to be the result of an epidemic, as in that reported by W. Pasteur in 1896, in which seven members of the same family were affected; although Gowers states that he has "been strongly impressed by two or three cases in which other members of the family have suffered from other affections of the nervous system"; and Sinkler also refers to the history of nervous diseases in the family, especially chorea. In adult cases there are sometimes the history of hemiplegias, etc., in the same family.

Long-continued ill health seems to have no causative influence on the disease; but a number of cases are noted where the attack occurred during convalescence from some one of the acute exanthemata, as scarlet fever, measles, rheumatism, chorea, whooping-cough, cholera infantum, typhus and typhoid fever, pneumonia, variola, and grippe.

It occurs with equal frequency in city and country, although the affection seems rare in some parts of the country, as in the locality in Ireland where during a period of thirty years not a single case has been met, nor are there any adults known in the district who are cripples in consequence of the disease. On the other hand, some localities are prone to recurrent epidemics.

The most conspicuous factor in the causation of this disease in children is the season of the year—a fact first emphasized by Sinkler some years ago. In the 350 cases quoted by this authority, in 270 the season in which the attack took place was recorded; of these, there were 213, or 78.8 per cent., attacked in the hot months of the year—that is, from May to September, inclusive.

TABLE.—(From Sinkler.)

	CASES.
	March, ... 9
<i>Spring</i> , 27 cases,.....	April, ... 4
	May, ... 10
	Month not stated, ... 4
	June, ... 27
<i>Summer</i> , 174 cases,.....	July, ... 52
	August, ... 65
	Month not stated, ... 30
	September, ... 29
<i>Autumn</i> , 59 cases,.....	October, ... 24
	November, ... 4
	Month not stated, ... 1
	December, ... 3
<i>Winter</i> , 10 cases,.....	January, ... 4
	February, ... 3
Total,.....	270

A similar table has also been more recently compiled by Starr, consisting of 452 cases, 327, or over 72 per cent., of which occurred during June, July, August, and September; 116, or a trifle less than 4 per cent. of the whole number, occurring during August. It will be observed that the greatest number occur during August, when the temperature is but little lower than in July—a fact explained by Sinkler in two ways: "First, because the intense heat of July has prostrated the children to such an extent that they more readily succumb to the spells of heat which follow; and, secondly, in August the relative humidity is greater than in July, the figures being 72.1 per cent. and 68.6 per cent. respectively." Gowers states that two-thirds of his cases were attacked between June and September, and Barlow, 27 out of 53 of whose cases were attacked during July and August, confirms his observation. The degree of humidity does not, according to Sinkler, show any influence on the number of cases unless associated with heat, nor does the range of temperature have any effect. When cold is the cause, it is usually after unusual heat.

Exposure to great heat, long exposure to the sun, and great fatigue from over-exercise, whether sudden or prolonged, are mentioned as causes of the attack. Exposure to cold and sudden chilling of the overheated body, as sitting on a stone step, sleeping in a newly built house, plunging into icy water after violent exercise,—as in cases of the writer's, or as in another case, the cold-pack being used to prevent "a cold" after a child's accidental fall into a lake in Switzerland,—or lying or sitting on the

damp grass, undoubtedly have a marked influence upon the production of the disease.

The exact relationship between digestive disturbances and the occurrence of anterior poliomyelitis is difficult of determination, as the attack at times occurs with an initial vomiting and gastric crisis.

Cases are frequently attributed to a fall, and traumatic hemorrhage into the substance of the cord, and symptoms resembling this affection may and do occur; but in the majority of cases in children, inasmuch as falling is ordinarily a common symptom of the onset, and the interval between the particular fall and the onset of the disease is great, the association is of no importance.

The epidemic and endemic occurrence of outbreaks of this disease would lend color to the exciting cause being microbic. Attempts have been made to isolate a microbe in this disease, but as yet have been without definite success. An analogy between this disease and the infectious eruptive disorder accompanied by paralysis which affects puppies, "*maladie des jeunes chiens*," in which a microbe has been demonstrated, was pointed out by Mathis in 1887. Schultze made a lumbar puncture on the thirteenth day from the onset of the disease in a boy of five and succeeded in isolating in the spinal fluid a micro-organism which he named the Weichselbaum-Jäger diplococcus. This boy afterward presented typical symptoms of infantile spinal palsy, but as a somewhat like form of paralysis occasionally follows cerebrospinal meningitis, there remains some confusion regarding this discovery.

The earliest epidemic observed occurred in 1843. But for many years after that they were not reported. In 1887, Medin reported 44 cases occurring during that summer in Stockholm, Sweden, with three deaths; in 1890, Briegleb reported at the Jena Congress an epidemic which he had observed; in 1894 Caverly reported an epidemic occurring in Rutland, Vermont, in which out of 132 cases—in some of which the cerebral tracts were involved—there were 18 deaths (the cases occurred from June to September, and domestic animals also suffered); in 1894 J. J. Putnam reported an epidemic which occurred near Boston; in Australia, in 1897, an epidemic was reported by Alston of 14 cases; Madison Taylor, about the same time, reported 7 cases, one of which was fatal, occurring in Cherryfield, Maine. Pasteur reported 7 cases in one family in 1896; but of all reports of epidemics, Brackett's report of the epidemic in North Adams, Massachusetts, of 10 cases, which occurred at this time, emphasizes most particularly the epidemic peculiarities; namely, the greater severity of all symptoms, the fever being higher, the palsy more extensive, the

sphincters at times being paralyzed, and there being a hyperesthesia in the severer cases which was longer in duration and more pronounced than usual. There was but one etiologic condition common to all these cases; namely, the residence of all but one of these patients being situated along the river banks.

In the epidemic reported by D. H. Mackenzie, which occurred in Dutchess County, N. Y., in 1899, there were 30 cases within ten miles, ten of which he treated, the disease being particularly fatal in adults.

In 1903 there was but one epidemic reported, and that occurred in California, being reported by Woods. In 1904 there was an epidemic reported by Lorenzelli, of Naples, and also one reported by Litchfield and Wade, which occurred in Australia.

In conclusion, primary dentition may be considered a frequent predisposing cause, and sudden chilling of the overheated body surface during the season of the year when the *relative* humidity is greatest the most common exciting cause. In other words, there is a disturbance of the thermotaxic mechanism in a previously weakened subject, the peripheral irritation of the sympathetic and other spinal nerves causing thereby the peculiar cord lesion characteristic of anterior poliomyelitis. The theory of a microbic origin would seem from the acute, epidemic, and endemic occurrence of the disease to be tenable, but more exact research is needed to render this theory positive.

Pathology.

The morbid process of anterior poliomyelitis consists of an acute destructive inflammatory lesion, mainly, though not exclusively, confined to the large multipolar cells of the anterior cornua in the gray matter of the spinal cord and their neuraxons passing out through the anterior roots, and the secondary degeneration and destruction of nerve-cells and marked changes in the peripheral nerves. In some severe cases there is a dorsal involvement, but in the large majority of cases the disease is confined to the cervical and lumbar enlargements of the cord.

The exhaustive researches of Charot and Joffroy and the autopsies performed by Drummond, Damaschino, Charlewood Turner, and Ashby in children, and in adults the researches by Bernhardt, Cornil and Lepine, Williamson, Mednir, Jagic, Caverly, and in very recent years by Taylor and Spiller, have established beyond cavil the exact nature and location of the lesion.

There has been, however, much dispute as to the hematogenous or neurogenous origin of the affection; Goldscheide and Seimerling especially being

instrumental in the present acceptance of the view that the blood-vessels are first affected. In favor of this view are the great vascular changes, and the fact that the nearer the ganglion cells are to the blood-vessels, the more are they degenerated, and also that it is not the cells of a definite group but those supplied by a certain blood-vessel or vessels which are affected.

The primary lesion is an inflammation which spreads over the greater portion of the cord, but is more intense in the cervical and lumbar enlargements, particularly in the anterior cornua, the most vascular part of the cord, and also in the anterior commissure, and the anterior septum. The most striking microscopic change observed is that present in the blood-vessels; they are greatly engorged and surrounded by leukocytes. The neuroglial tissue is loosened, and there is more or less cellular infiltration throughout, the cells being frequently grouped and mainly mononuclear. In the white matter leukocytes occur, but not in any great quantities. The exudation of leukocytes leads to both temporary and permanent damage to the motor cells in this region; even in cases examined a few days after the onset the number of ganglion cells is markedly diminished, showing that some of them have



FIG. 444.—ACUTE POLIOMYELITIS IN ADULT, SHOWING DISTRIBUTION OF ROUND-CELL INFILTRATION WITHIN THE GRAY AND WHITE MATTER (Spiller).

undergone complete degeneration. The cells may be swollen and colorless, containing chromatin granules in irregular masses, irregular processes and nucleus displaced and staining deeply, with vacuolar degeneration of the nucleolus. Later both the nucleus and protoplasmic processes disappear, leaving only the enlarged axis-cylinder springing from the cell. In the perivascular spaces round cells are frequently found with great distention of the space. The nerve-fibers of the anterior roots degenerate, the sheaths soon containing fatty globules and the axis-cylinders swelling and disintegrating. When the inflammation subsides, absorption of the exudate occurs, and a gradual improvement takes place in those areas where the destruction of the gray matter has been incomplete.

Marinesco has described a process of restitution of the injured cells, accounting for the regaining of a certain amount of muscular power.

In cases examined years or months after the onset of the paralysis there is evidence of secondary sclerotic changes, the destroyed areas in the anterior cornua being replaced by cicatricial connective tissue. The cornua are markedly diminished in size, but usually unequally so, one horn being not infrequently normal or presenting only slight alterations, while the other is markedly diminished and the columns of Clark disappear. Occasionally there is a colloid



FIG. 445.—POLIOMYELITIS IN ADULT OF SIXTY YEARS.

degeneration of the cornua. The blood-vessels are dilated and their walls thickened, and the debris of degeneration, corpora amylaceæ, pigment granules, etc., are abundant. The large ganglion cells are in different stages of degeneration and atrophy or are entirely absent. There is hyperplasia of the neuroglia, it being a coarse network containing large numbers of nuclei. The medullated fibers of the anterior roots are destroyed wholly or in part. Degeneration of the fibers of the pyramidal tracts may be found occasionally for a few segments above the main lesion, but is usually slight. Degenerative changes take place likewise in the peripheral nerves connected with the damaged cord; the muscles

waste; their fibrillar structure is replaced by fat globules, and finally the muscular tissue loses its identity; and there is an absence of even fat-globules, the fat being

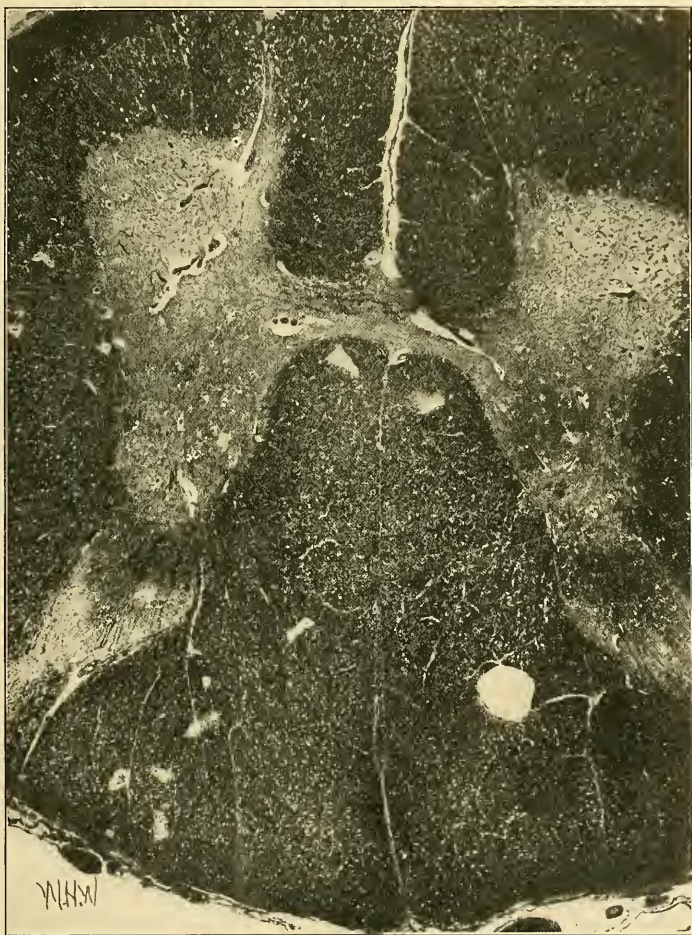


FIG. 446.—POLIOMYELITIS IN ADULT, AFTER SMALLPOX (Spiller).

replaced by hypertrophied connective tissue. According to Barlow, a muscle may, however, be much wasted in bulk without these microscopic changes being

present. The muscles which oppose these paralyzed muscles are much wasted from disuse; the arteries are diminished in size; the tendons are elongated and atrophied, and the growth and development of the bones is greatly retarded—so that there may be several inches shortening, the medullary portion being increased. Changes also occur in the articulations, the articular extremities of the bones often being atrophied, the cartilages thin and sometimes eroded. These changes are all atrophic.

Symptoms.

This affection occurs in two forms: the acute and the subacute or chronic. The former, occurring most frequently in children and being the most fruitful of deformities, will be the only one considered. This disease is usually seen by the orthopedic surgeon when atrophy, crippling deformities, and contractures present a comprehensive picture of the chronic stage; but to appreciate this affection thoroughly, it is necessary to study the early stages also. The course of the disease is most conveniently divided into four stages: (1) the initial stage; (2) stationary period, which lasts from a day to a month; (3) a period of "regression," which lasts from one to six months, during which the motor function returns to certain of the affected muscles; (4) a chronic stage, during which the degenerative changes and contractures occur, and during which slight and gradual improvement may intervene at any period.

1. The initial stage, or stage of invasion, may be characterized by a sudden paralysis, without any prodromal symptoms, but it is usually ushered in with moderate fever (102° F.), general irritability, aching pains in the loins, joints, and limbs, convulsions, vomiting, diarrhea, muscular twitchings, and great cerebral disturbance—headache, drowsiness, or even stupor. Multiple neuritis may be associated, and may form an aggravating complication by its persistence. These symptoms are usually overlooked by the friends, or attributed to dentition or general gastro-intestinal disorder, and it is not until the paralysis supervenes that the importance of these symptoms is recognized, and frequently the patient becomes convalescent and attempts to rise before even the paralysis is distinguished.

The pyrexia, though rarely high, may reach 105° or 106° F. The general cerebral disturbance is so marked as to have been attributed to meningitis, by both the layman and the practitioner.

The paralysis usually reaches its height at once, or in a very few days—occurring within the first three days of the beginning of the general constitu-

tional disturbance. A single group of muscles only may be paralyzed, or the paralysis may be monoplegic from the onset, but usually the paralysis affects all the extremities at the onset and rapid regression takes place. The severity of the initial attack seems to have no effect upon the extent of the paralysis which follows, since some of the most extensive and complete paralyzes have supervened after the mildest initial stage. The paralysis is monoplegic in its distribution in nearly half the cases, and is much more frequent in the lower than in the upper extremity. The relative distribution of the paralysis is well shown in the following table from Starr:

	DUCHENNE.	SEELIGMÜLLER.	SINKLER.	STARR.	TOTAL.
Both legs,.....	9	14	107	40	170
Right leg,.....	25	15	63	20	123
Left leg,.....	7	27	62	27	123
Right arm,.....	5	9	5	7	26
Left arm,.....	5	4	8	4	21
Both arms, ...	2	1	1	2	6
All extremities,.....	5	2	35	5	47
Arm and leg, same side, ...	1	2	26	4	33
Arm and leg, opposite sides,...	2	1	1	4	8
Trunk,.....	1	0	22	3	26
Three extremities, ...	0	0	10	2	12
	62	75	340	118	595

The muscles most frequently paralyzed are those of one lower extremity, particularly those of the leg. Muscles of the trunk are only affected in the severer grades of paralysis, and paralysis of the sphincters of the bladder and rectum is exceedingly rare. When single muscles are affected, the deltoid suffers alone more frequently than any other muscle of the arm, and the tibialis anticus is paralyzed alone oftener than other muscles. The flexors of the foot and the extensors of the leg are next in the order of frequency. Paralysis of the facial muscles is rare, though cases have been observed by the author. Fortunately, certain muscles always escape paralysis, as the muscles of the eyeballs, ears, larynx, and those of respiration; the diaphragm and intercostals are only affected in the most exceptional instances. Universal paralysis, when it occurs, according to my observations, is quickly fatal from failure of respiration.

2. The stationary or paralytic stage is characterized by a period of from one to six weeks, or even four months, during which the muscle paresis remains stationary. The muscular paralysis may be limited to one or both arms or legs, to one arm and the opposite leg (crossed paralysis), or to definite groups of muscles, according to the extent of the nerve-cell involvement. The bladder

and rectum remain uninvolved. As a rule, however, the regression occurs early, the first improvement usually taking place in the parts last affected, and extending until all the muscles have recovered, except those which are to remain permanently paralyzed. The reflexes, both superficial and deep, are lost. Sensation usually is not affected, but in rare cases it may be diminished and even entirely lost. If, however, multiple neuritis complicates the paralysis, severe hyperesthesia is associated. The circulation in the skin is interfered

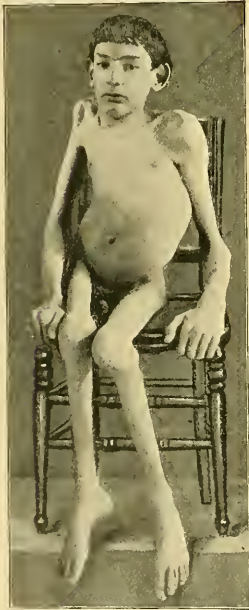


FIG. 447.—PHOTOGRAPH OF SEVERE CASE OF INFANTILE SPINAL PARALYSIS.

with by the cord lesion, and the temperature of the part affected is much reduced, there being frequently two or three degrees difference between the healthy and the affected limb, and in exceptional cases 10° , 20° , 30° , or even 40° . The circulation is sluggish, giving rise to a mottled, dusky purplish discoloration of the skin; the skin is easily excoriated under friction, but is free from idiopathic ulcerations, sloughs, or severe atrophic changes. The muscle irritability is markedly changed during this early period, the reaction to the faradic current being usually entirely absent in those muscles that are permanently paralyzed.

The muscle irritability to the continuous current during this period is increased, but becomes gradually lessened later, and may entirely disappear. To the continuous galvanic current it still continues to respond, though the reaction differs essentially from that of healthy muscles, the change being the so-called "reaction of degeneration," due to the degeneration of the peripheral nerves. The electric formula is reversed, a change to be referred to later under diagnosis.

3. The stage of regression, commencing after two or three days, or after a delay of three or four months, continues till all the muscles have regained their power except those which are to remain permanently paralyzed. This includes a period which terminates only with the cessation of growth itself.

Recovery in the affected muscles is indicated by an increased response to the interrupted current, while a diminished response and progressive atrophy mark the advance of permanent paralysis in the muscles which are to remain

permanently affected. This gradual regression of the original paralysis is a remarkable clinical observation, in a few instances entire recovery occurring in all the affected muscles, and in others recovery ensuing after one or more attacks and permanent paralysis finally resulting. During this period of regression the general health is usually excellent, all the bodily functions are per-



FIG. 448.—INFANTILE PARALYSIS, SHOWING ATTITUDE IN WALKING.

fectly performed, the child appears perfectly well, and nothing but the paralysis and atrophy remain to indicate the inflammatory stage passed.

4. The chronic stage, characterized by deformities and dislocations from atrophy and contractures, is of peculiar interest to the orthopedic surgeon. Six months after the onset of the disease marks the limit of rapid improvement, and the improvement, which may go on for years, is always slow and very slight after this period. At this time may be estimated pretty accurately the amount

and distribution of the permanent paralysis, which is always much less than at first appeared. This permanent paralysis may affect only a single muscle or may include the muscles of all the extremities and some of the trunk muscles.

The symptoms of the paralysis of individual muscles and groups of muscles produced by paralysis of their motor nerves are well illustrated in the following original schedule:

Cervical Nerves.—Paralysis of the anterior division of the third and fourth cervical nerves causes paralysis of the trapezius, as does also paralysis of the spinal accessory, causing droop of the point of the shoulder and a falling back of the head.

Posterior Thoracic.—Paralysis of the serratus magnus causes a downward and backward falling of the vertebral border of the scapula.

Upper Extremity.—*Suprascapular Nerve.*—Paralysis of the suprascapular nerve causes paralysis of the supraspinatus and infraspinatus muscles, as shown by the inability to perform external rotation of the humerus, and paralysis of the upper and lower subscapularis interferes with the inward rotation of the humerus through paralysis of the subscapular muscles.

Circumflex.—Paralysis of the circumflex causes paralysis of the deltoid and teres minor muscles, as shown by a flattening of the shoulder with an exaggerated prominence of the acromion, inability to abduct the arm, and sometimes a subluxation of the humerus. Paralysis of the brachialis anticus, biceps, and supinator longus is often associated.

Musculospiral.—Paralysis of the musculospiral causes paralysis of the triceps and all the muscles on the posterior aspect of the forearm, especially the extensors of the wrist and fingers and the supinators, causing "wrist-drop" and inability to supinate the forearm or extend the elbow voluntarily.

Lower Extremity.—*Anterior Branches of Lumbar Nerves.*—Paralysis of the anterior branches of the lumbar nerves causes paralysis of the iliopsoas muscle, causing inability to flex the thigh. The leg remains extended if the glutei are intact. This condition is rare except in general paralysis.

Gluteal.—Paralysis of the gluteal nerve causes paralysis of the glutei, causing flattening of the buttocks, and inability to abduct and circumduct the thigh.

Anterior Crural.—Paralysis of the anterior crural nerve causes paralysis of the quadriceps extensor femoris, as shown in the adduction of the leg, flexion of the knee, and inability to extend the knee.

Anterior Tibial.—Paralysis of the anterior tibial nerve causes paralysis

of the tibialis anticus, extensor proprius pollicis, extensor longus and brevis digitorum, and peroneus tertius, causing talipes equinus, toes flexed, and dragging on ground in walking, with hollow sole of foot. If only the tibialis anticus muscle is involved, the foot would be in slight valgus.

Musculocutaneous.—Paralysis of the musculocutaneous nerve causes paralysis of the peroneus brevis and the peroneus longus, causing talipes-varus and pes planus.

Internal Popliteal and Posterior Tibial.—Paralysis of the internal popliteal and posterior tibial nerves causes paralysis of the muscles of the calf, tibialis posticus, flexor longus digitorum, flexor longus hallucis, causing talipes calcaneus cavus, inability to extend ankle-joint and adduct foot, and hyper-extension of the distal phalanges of the toes.

Dorsal and Lumbar.—Paralysis of the posterior division of the dorsal and lumbar nerves, if bilateral, causes paralysis of the extensors of the back, causing inability to extend the back, hence a constant maintenance of the body in a position of lordosis, and a projection backward of the shoulders. If the paralysis is unilateral, scoliosis is produced.

Paralysis of the anterior division of the dorsal and lumbar nerves causes paralysis of the abdominal muscles, causing lordosis without projection backward of the shoulders.

The deformities resulting from infantile paralysis have been ascribed to one of three causes: (1) the relaxation of the muscles and ligaments, and the undue action of their opponents; (2) the result of growth upon the limb, the paralyzed parts remaining undeveloped; and (3) stretching of the paralyzed muscles at the onset of the paralysis. The first cause—the unequal action of the muscles—undoubtedly has its influence in certain instances, and is an important factor in the production of deformity, particularly where a single muscle or group of muscles is involved; but the second cause—that they are due to atrophy and *arrest of growth*—is by far the most important, and as such deserves emphasis. Nearly all these deformities may be accounted for on purely mechanical grounds. It has been demonstrated that the weight of the part in the position assumed at rest in paralysis, and the muscular insufficiency of the affected parts, which subjects the articular surfaces to excessive pressure when in use, cause the deformities.

Thus in paralysis of the muscles of the anterior region of the leg the deformity is due entirely to the force of gravity, the foot falling into the position of equinus, and the anterior portion of the foot being adducted by its own weight.

In these cases in the early stages there is little or no contraction, and the deformity can be readily reduced by manual pressure. Attention has also been called to the fact that the abnormal position assumed by the affected limb eventually becomes permanent through the weight of the body and abnormal growth, and not, as was formerly assumed, from contraction. The apparent contractures which are met in this affection, as the muscles about the hip, knee, ankle, and foot, are not, then, due to contracture of these structures, but are the result of abnormal or normal growth of the bones and antagonizing muscles; these affected structures, from paralysis and atrophy, remaining in their original condition. This corresponds to the so-called "adapted atrophy," the changes ensuing in consequence of the mechanical relations of the foot to the leg. Thus, in talipes varus resulting from infantile paralysis the plantar fascia is not *per se* contracted, but its growth being retarded or abolished, and the foot growing in length, the apparent contracture has resulted. Sometimes the paralysis causes an arrest of development in the growth of the bone, producing a stunted appearance.

3. There is still one other factor at work which has been suggested as the cause of the more severe paralysis of certain groups of muscles over others, as in the anterior muscles of the thigh and leg, and this is the stretching of these muscles by the weight of the foot and leg in lying and sitting. This stretching of the muscles, if all the muscles were equally affected at the onset, is sufficient to account for the severe paralysis remaining after the other groups have recovered.

The deformities arising from infantile paralysis may be considered under three groups: deformities of the upper extremity, deformities of the lower extremity, and deformities of the trunk.

Deformities of the Upper Extremity.—The deltoid, though not a common seat of paralysis, suffers alone more frequently than any other muscle of the upper extremity. In addition to the inability to raise the arm, there is a loss of rotundity in the shoulder, and a prominence of the acromion process, the shoulder presenting a flattened appearance, and sometimes a subluxation. Associated with paralysis of other muscles—the supraspinatus and infraspinatus, biceps, and triceps—it constitutes the so-called "upper-arm type" of Erb, a combination which differs from the "upper-arm type" of Remak, in which the supinator longus is affected along with the brachialis anticus, biceps, and deltoid. The trapezius, subscapularis, and serratus magnus are occasionally affected.

Paralysis of supinators and extensors of the hand and the adductors of the thumb, when it occurs, may result in flexion of the hand and fingers, with restricted mobility, and may prevent the apposition of the thumb with the other digits. When the supinator longus escapes, but the extensors of the wrist are affected, it constitutes the so-called "forearm type" of Remak. A deformity amounting to club-hand may likewise occur. Contraction of the shoulder, elbow, and wrist resembles post-hemiplegic contractures.

Deformities of the Lower Extremity.—

Paralysis and atrophy may affect the entire limb, and give rise to the withered, useless, flail-like, doll-like limb known as "*jambe de polichinelle*," or but a single extensor of the foot may be involved, influencing locomotion but little or not at all. Fortunately, the paralysis is more frequently partial than complete.

The extensor quadriceps and glutei are the muscles most frequently affected in the thigh. The limb flexed and adducted cannot be made sufficiently rigid to sustain the body-weight, and extension and outward rotation are lost.

Contraction of the sartorius, tensor vaginae femoris, and, in rare cases, the iliopsoas muscles, prevents the limbs being brought underneath the body, except by the forward rotation of the pelvis and the production of marked lordosis in the lumbar region of the back.

Dislocation of the hip may occur spontaneously from relaxation of the muscles and ligaments, or may result from the weight being improperly thrown upon it. Dislocation upon the dorsum of the ilium is the most frequent, but displacement in other directions may occur, and the relaxation of the joint may be very great. Shortening and great mobility, without pain or other symptoms, characterize the deformity, and if the dislocation is allowed to remain, a new cavity for the head of the bone will in time be formed.

At the knee-joint inability to extend the knee is the most common deformity, and great laxity with lateral mobility may occur. Other deformities



FIG. 440.—INFANTILE SPINAL PARALYSIS. MONOPLEGIC TYPE.

of the knee arise from use of the joint, the body falling improperly upon the relaxed ligaments. In this way occur the hyperextension of the knee, or recur-



FIG. 450.—INFANTILE PARALYSIS. PARAPLEGIC TYPE.

vation, in which the knee is bent backward beyond the perpendicular, and the head of the tibia lies in a plane posterior to the line of the femur.

Permanent flexion from contraction of the hamstring tendons and knock-knee from elongation of the internal lateral ligament result in severe cases. Outward rotation of the tibia upon the condyles of the femur results from undue contraction of the biceps.

The most frequent varieties of club-foot are equino-varus and valgus. Equino-varus results from paralysis of the anterior tibial and peronei muscles. If, however, the peronei remain intact, equinus results. Talipes varus is rare, and talipes calcaneus is the rarest of all the deformities from poliomyelitis.

Talipes valgus acquisitus and talipes calcaneo-valgus result from the relaxation of the ligaments, and the improper transmission of the body-weight upon the ground, and the most severe forms of these deformities result from infantile paralysis.

In valgus the changes which ensue from the effects of growth upon the mechanical relations of the foot to the leg are observed, and in severe cases contraction of the peronei tendons is noted. Likewise in varus, contraction of the plantar fascia is of frequent occurrence.



FIG. 451.—INFANTILE PARALYSIS. PARAPLEGIC TYPE.

True talipes calcaneus almost never occurs, and its existence has been doubted. What does occur, however, is known as pes cavus. The heel is lowered by relaxation; the anterior part of the foot remaining in the normal¹ plane gives an arched appearance to the sole of the foot, and an apparent elevation of the anterior portion of the foot.

These deformities occur in the following order of frequency: (1) Talipes equinus; (2) equino-varus; (3) equino-valgus; (4) calcaneo-valgus; (5) talipes varus; and (6) calcaneus. When both feet are affected, equino-varus of one foot is generally found with equino-valgus of the other.

Deformities of the Trunk.—Paralysis of the trunk muscles in severe cases gives rise to great distortion and may render the patient perfectly helpless.

Paralysis of the extensors of the back, when bilateral, produces lordosis on standing, inability to sit erect, and projection backward of the shoulders. This lordosis is produced by the patient's effort to maintain his equilibrium. If flexion occur, voluntary extension would be impossible; hence extension is constantly maintained. When unilateral, it results in lateral curvature, with inability to move the trunk toward the paralyzed side.

Paralysis of the abdominal muscles produces lordosis also, but without backward projection of the shoulders.

The lateral curvature of the spine resulting from infantile paralysis may be either (1) *static*, where the trunk muscles are unaffected but where the pelvis is tilted from inequality of one lower limb from paralysis and atrophy, or where faulty spinal attitudes are habitually assumed from paralysis and atrophy of the muscles of one upper extremity, or (2) *paralytic*, from unilateral paralysis of the intrinsic spinal muscles, that important group which controls the movements of the individual vertebrae, or the great erector spinæ mass of muscles, which controls the movements of the column as a whole.

Diagnosis.

The symptoms in well-established infantile paralysis are so strikingly peculiar that a diagnosis is not difficult, and yet in the early stages, before the development of the paralysis, a correct diagnosis is most difficult to establish. The pyrexia, convulsions, and vomiting are frequently mistaken for cerebrospinal meningitis, acute rheumatism, acute cold, indigestion, etc., and the paralysis which ensues is often mistaken for the prostration following some acute affection.

The characteristic symptoms upon which the practitioner must rely for a correct establishment of a diagnosis are:

1. Sudden onset.
2. Motor paralysis (sensation unaffected), tending toward regression.
3. Lost or diminished reflexes.
4. Paralyzed muscles are at all times flaccid.
5. Change of electromotor reaction.
6. Atrophy and deformities.

It should be recollected that the prostration following acute illness never amounts to complete loss of power, and that reflex irritation, as from phimosis, ascariides, and similar peripheral irritations, may cause some of the symptoms, but their stationary character, and subsidence upon removing the cause, should make the diagnosis clear.

The only affections which cannot be differentiated from infantile paralysis by an electric examination are the peripheral palsies, where localized paralyses result from traumatism or the presence of an enlarged gland or tumor on a nerve—in fact, wherever the muscles are cut off from the influence of the trophic centers.

The electric reaction of the muscles furnishes by far the most important diagnostic test.

For the following practical description of the electric reactions, the writer is indebted to Dr. Charles S. Potts, Associate in Neurology in the University of Pennsylvania.

One of the most important symptoms of acute poliomyelitis is the changed behavior of the affected muscles and the nerves supplying them, when stimulated by the electric current. This change is present to a greater or less degree whenever a muscle or nerve is cut off from its trophic center, and has been termed by Erb the reaction of degeneration. In order to more fully comprehend what this alteration is, a brief account of how the muscles and nerves act when normal may not be out of place.

1. *Response to the faradic current.* When one of the electrodes is placed either over the muscle or the nerve supplying it, the other being placed at some indifferent point, there is a contraction of the muscle at each opening and closure of the circuit.

2. *Response to the galvanic current.* If the negative pole, termed the cathode, is placed over the nerve and the other at some indifferent point, the sternum preferably, and the current is gradually increased in strength and

the circuit alternately opened and closed until a response be obtained, we will find that our first muscular contraction will take place when the circuit is closed; this is called the cathodal closure contraction. No contraction will take place when the circuit is opened; this can only be elicited by the most powerful current, and is for obvious reasons never obtained in a healthy human being.

If now for the cathode we substitute the positive pole, termed the anode, we will get no response until we increase the current strength, when contractions of about equal intensity will occur at both the opening and closing of the circuit; these are termed respectively the anodal opening and closure contractions.

These contractions have been conveniently formulated as follows:

Ca = cathode.	C = contraction.
An = anode.	C' = strong contraction.
Cl = closure.	C'' = very strong contraction.
O = opening.	

Very strong current.

Weakest current.

Ca Cl C.

Ca Cl C''.

An Cl C'.

Strong current.

Ca Cl C'.

An O C'.

An Cl C' }
An O C' } about equal.

Ca O C (very weak contraction).

Practically the muscles when directly stimulated respond in a manner similar to that which ensues when the supplying nerve is stimulated.

When the muscle and nerve are separated from their trophic centers, the mode of reacting to the current undergoes a radical change. Further, the nerve and muscle each respond differently. If the case is seen immediately after the onset of the disease, which it rarely is, and the nerve or nerves influenced by the diseased cells are stimulated, we may find a stronger contraction of the respective muscles supplied by them taking place, with both the faradic and galvanic currents, than would take place if they were normal. This lasts for one or two days, when a progressive decrease commences which continues in marked cases until in the course of a week no response can be elicited by either form of current. The muscle when excited directly acts similarly with the faradic current, but with the galvanic current the following is noticed: During the first week a slight decrease in irritability will be noticed, to be succeeded

by a marked increase lasting from three to six weeks; also, instead of the normal short, sharp contraction we will have one which is slow and long-drawn-out, in some cases almost tetanic in character, and in place of the Ca Cl C alone being excited by the weakest current that will cause a contraction, we will find either the An Cl C equally prominent or in severe cases taking place first; this change in the mode of contraction is expressed by formula thus:

$$\text{An Cl C} = \text{Ca Cl C},$$

or in severe cases,

$$\text{An Cl C} > \text{Ca Cl C}.$$

Ca O C can also be elicited and at times equals An O C, although it has never been observed greater; we express this change by formula as follows:

$$\text{Ca O C} = \text{An O C}.$$

At the end of this period the power of response gradually becomes weaker; stronger currents become necessary to produce contractions. Ca O C disappears, then An O C, until in very severe cases we can only get a weak An Cl C, which, if the case goes from bad to worse, finally ceases.

In very mild cases we often observe what is termed a partial reaction of degeneration, the difference being that when the nerve is stimulated the muscle responds normally or with only a slight decrease in irritability. The muscles act when directly stimulated as described above.

To demonstrate these changes as detailed above takes skill and experience, and even then they cannot always be shown. For the practical purposes of diagnosis a knowledge of the following facts will suffice, and these are really the essential features of the degenerative reaction.

1. The loss of the power of a muscle to contract when stimulated by faradic current, and the response, if a recent case, of the muscle to a weaker galvanic current than that which normally causes a contraction.

2. The existence of the long wave-like contraction and An Cl C equaling or recurring before Ca Cl C.

Some valuable points in prognosis may be obtained by a study of these reactions. If after several weeks only the partial degenerative reaction is present we can predict a comparatively speedy recovery, and the prognosis is correspondingly worse the farther advanced the reaction is, and the longer it persists without any tendency to improvement. This improvement is manifested first by the gradual return of the nerves to the normal reaction, the changes evolved by direct stimulation of the muscles persisting for some time after the

irritability of the nerve returns. If only An Cl C is present, the chances of complete restoration are extremely slight and a prolonged course of treatment will be necessary to effect any. If no response can be elicited, the case is practically hopeless.

Differential Diagnosis.

Infantile paralysis must be distinguished from cerebral paralysis, myelitis, diphtheritic paralysis, rachitic pseudo-paralysis, spastic paraplegia, cerebro-spinal meningitis, progressive muscular atrophy, pseudo-hypertrophic paralysis, birth or pressure palsies, hemorrhage into the cord, multiple neuritis, congenital dislocation of hip, and hip-, ankle-, and shoulder-joint disease. Of these, it is most frequently confounded with other forms of paralysis (spinal or cerebral) and progressive muscular atrophy and hip-joint disease.

Cerebral Paralysis.—It is with this affection, particularly in its earlier stages, that infantile paralysis is most frequently confounded, and from which, when the latter disease is hemiplegic with involvement of the facial nerve, it is difficult and almost impossible without an electric examination to distinguish it.

In cerebral paralysis the onset is usually sudden, convulsions frequently occur, and hemiplegia with facial paralysis results.

In the disease under consideration, when hemiplegia occurs the arm usually soon regains its power and the leg remains paralyzed, while the reverse occurs in cerebral paralysis. In the latter, also, the muscles of the affected part are frequently rigid; the tendency to atrophy and deformity (except post-hemiplegic contractures), the changed electric reactions, and the lowering of the temperature of the affected part are all absent. Moreover, the causes of cerebral paralysis in children—meningitis, cerebral hemorrhage, and infectious diseases—add their own appropriate symptoms to the essential symptoms of this affection.

In the more difficult cases the electric reactions alone will distinguish between the two affections.

Myelitis.—Acute transverse inflammation of the cord is characterized by complete loss of power, with marked loss of sensation, with diminished reflex excitability, and electro-muscular contractility and subsequent atrophy of the affected muscles. The loss of sensation, the tendency of the affection to grow progressively worse, and the grave character of the affection would serve to distinguish it.

Diphtheritic Paralysis.—Diphtheritic paralysis may be distinguished

by the previous history, the association of paralysis of the palate and pharyngeal muscles, the unchanged electric reactions, and the absence of severe atrophy. The writer has observed a child suffering from both affections at the same time. Moreover, the paralysis of the extremities rarely arises suddenly, and, as a rule, they involve a series of muscles at the same time, improving in the same order as the individual muscles became affected.

Rachitic Pseudo-paraplegia.—This is not so much a paralysis as an indisposition to use what muscular power is retained on account of the general tenderness. The loss of power may be almost as great as in infantile paralysis, but the gradual onset, the association of other evidences of rickets, especially local sweating and nocturnal fever, the absence of atrophy, and the normal electric reactions will serve to distinguish it.

Spastic Paraplegia.—The tetanoid rigid condition of the limbs, the gradual onset, the exaggerated reflexes, the absence of atrophy, and the unchanged condition of faradic irritability would readily distinguish it.

Cerebrospinal Meningitis.—This may at the onset be confounded with infantile paralysis. The epidemic nature of the disease, the opisthotonos, the dorsal pain, hebetude, coma, and convulsions, the progressively grave character of the affection, are important in arriving at a correct diagnosis. Moreover, the paralysis, while frequently hemiplegic, is not permanent.

Progressive Muscular Atrophy.—"Wasting palsy" is of rare occurrence in infancy and childhood, and the gradual onset, corresponding to the increase of the atrophy, its progressive nature, and the presence of faradic contractility and the reflexes as long as any muscular fiber remains, will suffice to distinguish it in the earlier stages. Later, during the stage of contraction and deformity, the generalized atrophy of this disease will be sufficiently characteristic.

Pseudo-hypertrophic Paralysis.—Although motor weakness is the first symptom to attract attention in this affection, the increased size of the muscles, unattended by any marked electric changes, is sufficiently characteristic; and subsequently, when atrophy sets in, its general distribution, the history, the deformities from muscular contractures, the disappearance of the knee-jerk as the disease advances, the entire absence of the reaction of degeneration, will readily distinguish this affection from the one under consideration.

Pressure or Traumatic Palsies.—Peripheral paralysis from nerve injury, as in birth palsies immediately after instrumental delivery, from tight bandaging ligature, or from pressure of an enlarged gland or tumor on a nerve, is usually limited to the distribution of a single nerve and has associated loss of sensibility

and trophic skin lesions. In all such the course of the great nerves of the part should be examined, for in such cases the electric examination fails, since it is identical.

Hemorrhage into the Cord.—Traumatic hemorrhage into the anterior cornua is identical with anterior poliomyelitis, cases being recorded by Allbutt and Turner. Hemorrhage into the gray substance of the cord resembles the affection under consideration in its sudden onset, the subsequent atrophy, the absence of reflex action, and the loss of electric irritability; but differs from it by the absence of the initial pyrexia, the almost instantaneous occurrence of paralysis, the association of sensory disturbances, the paralysis of the sphincters, the occurrence of bedsores, and other trophic changes.

Multiple Neuritis.—Of rare occurrence in childhood, it differs from poliomyelitis in the gradual onset, gradual loss of response to the faradic current, the absence of regression, the marked hyperesthesia, and tenderness over the nerve-trunks. Motion is painful. It is important for the surgeon to be familiar with the uncommon forms of multiple neuritis, such as Sinkler has recently recorded from alcohol, coal-gas poisoning, metallic poisoning, infectious diseases, etc. Moreover, the association of the two affections should not be forgotten.

Congenital Dislocation of Hip.—When slight, this may resemble the disease under consideration, but may be distinguished by the slight atrophy, the normal electric reactions, the elevation of the trochanter above the Roser-Nélaton line, and the possible reduction of the deformity by traction. When the hip is dislocated in infantile paralysis, the difference would be less, but the history of the case and the electric changes would still be available for diagnostic purposes.

Hip-joint Disease.—When sudden and associated with joint pain and tenderness, severe muscular atrophy, and modified response to the faradic current, the resemblance of this disease to anterior poliomyelitis is great, but the characteristic muscular fixation, the gradual onset, deformed position of the limb, night-cries, etc., would serve to distinguish it. The same symptoms, being those of osteitis in general, would serve in a measure to distinguish ankle-joint and shoulder-joint disease.

Prognosis.

With modern therapeutic, mechanical, and operative means, the prospects of improvement in this affection are now exceedingly promising. The

effect of treatment in this affection is most marked. Without treatment of any kind, after the stationary period the paralysis will usually improve for one or two months, more slowly for two to four months, after which it remains permanently or improves very slowly. After a time atrophy, contracture, relaxation, and malposition lead to crippling deformities, which locomotion rapidly and indefinitely increases. Treatment faithfully and persistently continued is frequently rewarded by the return of power and usefulness in an atrophied and helpless limb, while apparatus and surgical skill will not only correct deformities, but will hasten and increase the improvement.

During the initial stage the danger to life is exceedingly slight, though in very rare cases the patient may succumb at the onset from respiratory failure.

Cerebral complications add to the gravity of the prognosis. An attack of this affection may during convalescence render the patient less resistant to other and more fatal diseases. There is no evidence to prove that moderate deformity from this disease shortens the tenure of life. After the paralysis has become stationary, in about a week or ten days, it is not likely to increase, and the possible improvement or recovery of the affected muscles may be estimated by an electric examination. Perfect recovery is rare, but improvement may be looked for even in the severest cases. The muscles which do not respond to the faradic current will probably remain permanently paralyzed. After a few days the muscles which at first gave no response may feebly respond, and these may be expected to recover partially or completely. When no loss of faradic contractility is observed after the paralysis has become permanent, recovery may be predicted in a few weeks or months. When the faradic contractility gradually fails, wasting and paralysis for an extended period may be predicted. When complete paralysis and marked atrophy are observed, within two or three months the permanency of the paralysis may be predicted. As long as the feeblest response remains to the faradic current improvement may be predicted, but if the "reaction of degeneration" is present the paralysis may be considered absolutely permanent. Even in the severest cases great improvement may be obtained by mechanical and operative treatment, the possibilities being only limited by the extent of the paralysis and amount of atrophy of the upper extremities. Only cases which are so extensively paralyzed as to be unable, with apparatus, to use a wheel-crutch, are not amenable to treatment; and frequently, under modern methods, children apparently doomed to spend

the rest of their life as helpless cripples upon the floor are restored to health and usefulness.

Prophylaxis.

A word of warning may here be given, since certain simple prophylactic measures may prevent the advent of this disease with its terrible crippling deformities. Since its principal exciting cause is the sudden chilling of the overheated surface of the body during a season of the year when the greatest mean relative humidity of the atmosphere is accompanied with great heat, due precaution on the part of nurses and parents may prevent its occurrence. To this end children should not be allowed to become greatly overheated nor be exposed to the sun for long periods, and should not be allowed to lie on damp grass nor sit upon damp stones when in an overheated condition. The body, especially in delicate children, should be well, but lightly, covered, preferably with light natural wool or hygienic garments, and under no circumstances should a child be allowed to take a cold or tepid bath when greatly overheated.

Treatment.

The character of the treatment will depend upon the stage or period during which the disease is seen.

Medical Treatment.—*The Stage of Onset.*—During the first stage, before the development of paralysis, the indications are to reduce the temperature, to remove the exciting cause, and to relieve the urgent symptoms present. Active measures at this time may limit the amount of destruction in the cord. A brisk purge, preferably of calomel, rhubarb, or magnesia, should be administered, and a febrifuge mixture be prescribed. If worms in the intestines are suspected as the cause, santolin should be added to the calomel. A general hot bath should be administered, and the child placed upon the side or face to limit stasis of blood in the cord; mustard plasters, tincture of iodine, or dry cups, should be applied to the spine, especially over the cervical and lumbar enlargements.

For dental irritation the gums should be lanced at once. If genital irritation exist and phimosis be suspected as the cause, circumcision will be indicated as soon as the more acute symptoms have subsided, and may be followed by the speedy amelioration of the paralysis.

If the disease be ushered in with a convulsion, cold may be applied to

the head. Ergot is strongly recommended, and ten drops of the fluid extract may be administered to infants of six months and one-half dram to children between one and two years. Ergotin may be given by suppositories when the patient cannot swallow. Belladonna, mercurial inunctions, hydrargyrum cum creta, and iodid or bromid of potassium have been recommended in the acute stage. Rest and quiet, with a sterilized-milk diet, should be insisted upon, and a moderately cool temperature should be, if possible, secured. Strychnin has been recommended both internally and by hypodermatic injection, but its value is greatest in the paralytic stage of the disease when no signs of the initial irritation remain.

Stage of Paralysis.—During the acute and the early part of the stationary period the paralyzed parts are to be protected from strain and pressure, and measures are to be adopted which will diminish the amount of the deformity, hasten the regression, and secure, if possible, the maximum improvement.

The limbs should be enveloped in sheet lint or lintine and neatly bandaged; should be placed upon pillows and supported by sandbags, pillows, etc., in such a manner as to avoid any undue tension and stretching upon the paralyzed muscles or relaxed ligaments. The weight of the bedclothes must be taken off the toes by a bed-hoop or other device. If the paralysis be more extensive, a canvas-covered frame or a wire cuirass may be employed to secure perfect rest to the palsied parts, and enables the child to be carried about. The arm when paralyzed may be secured in a sling or preferably a well-applied roller bandage, pressure being carefully avoided. It is essential that the limb should be kept warm at all times. The limb should be constantly incased in woolen, and in winter be additionally protected by chamois or buckskin. Dry heat may be applied several times a day by sitting before the fire with the paralyzed limb placed through a hole in a sheet of heavy cardboard or wood. Friction, rubbing, or massage is very useful, and is best applied by the bare hand, but sweet oil or vaselin may be used if the dry rubbing produce irritation.

Massage is best given by persons skilled in its employment, but where the expense is too great the rubbing may be substituted. Its use, at first, must be limited, and ten or fifteen minutes will be sufficiently long if only one extremity is affected, and the time may be gradually extended to twenty or thirty minutes. The massage is best applied at night after the limb has been thoroughly warmed, and consists of: First, firm stroking, applied over

the entire limb from the foot to the hip; second, friction applied from below upward, and followed by stroking; third, kneading, the tissues being carefully separated; and, fourth, percussion over the muscular parts of the entire limb.

For the details of these movements the reader is referred to Part I.

Finally, the foot, leg, and thigh should be rotated gently and firmly, and the joints should be carried through their normal movements several times.

A period of rest must follow these manipulations at all times, so that they are preferably performed at bedtime.

Exercise of the paralyzed limb, preferably on the principle of the Swedish movement cure, will form a valuable adjunct to the rubbing or massage.

Muscle and brain are developed by reciprocal action and every movement of a composite nature develops equally the gray centers of the brain and cord. Active muscular exercise, however obtained, enables the weakened muscles to regain their power and daily places them at a greater advantage. For the general effect of exercise the reader may be referred to one of the writer's former papers upon "Physical Development in Children" (Keating's "Cyclop. Dis. of Children," vol. iv).

In the treatment of this affection every movement of the paralyzed part which can be accomplished, provided the muscles are not overtaxed, may be employed. No exact series of exercises can be given, and the exercises must be varied to suit the individual case. To the same end apparatus should be early employed, to enable the child to walk as soon as possible, and so increase the amount of exercise.

Electricity is the most important remedy at our command to restore power to the paralyzed muscles. Its use should always be deferred until all symptoms of inflammation have subsided, as seen by the absence of fever and hyperesthesia. The author allows four to six weeks to elapse before beginning the electric treatment. For two or three weeks only the mildest currents may be employed and these only for a limited period. The rule in the administration of electricity is to use the current which will give the greatest amount of contraction with the least amount of current and the smallest amount of pain. The slowly interrupted faradic current is to be preferred, and each muscle may be made to contract three or four times and the treatment should be applied daily. Galvanism is to be substituted when the muscles fail to respond to the faradic current. The good effect of the electricity is observed in the increasing size and power of the paralyzed part, and the

improved circulation and appearance of the skin. Electricity is also useful, after the parts have reached their maximum development, to maintain the nutrition of the tissues. Strychnin is a valuable adjunct to electricity in this stage. In the later stages massage and active muscular exercise will be of more importance than electricity.

Mechanical Treatment.—The principles involved in the mechanical treatment of infantile paralysis are: first, the support and protection of the limb in a manner which will render it most serviceable for progression, and at the same time exercise as much as possible the weakened muscles; and, second, the prevention and correction of deformities. The lightest form of apparatus which will accomplish this should always be selected, and particular attention must be taken to have the bands thoroughly padded, and friction must be avoided, since the circulation of the part is poor. Rubber elastic bands are of service in some forms of apparatus to assist weakened and partially recovered muscles, but rigid appliances with locks and catches at the joints are to be preferred, the main use of braces being the support of the joints.

Mechanical appliances will be indicated whenever the limbs cannot support the weight of the body, and where in locomotion the weight of the body produces distortion and deformity of the limbs. No special form of apparatus can be given to meet all cases, and the changes and alterations required will tax to the utmost the ingenuity of the surgeon and the skill of the instrument-maker.

The conditions requiring mechanical appliances may be considered under four divisions

1. Paralysis of the lower extremity.
2. Paralysis of the trunk and lower extremity.
3. Paralysis of the trunk.
4. Paralysis of the upper extremity.

Paralysis of the lower extremity. The application of mechanical appliances for the relief of paralysis of the lower extremity will include appliances for paralysis of the leg with associated varus, valgus, and calcaneus; appliances for paralysis of the thigh muscles; and appliances for complete paralysis of the lower extremity.

When simple calcaneus results from paralysis of the anterior muscles of the leg, the foot may be prevented from fully extending by attaching lateral steel uprights to the ordinary shoe, and the addition of a right-angle stop-

joint opposite the ankle-joint. A single upright of this kind upon the outer side of the leg extending to a little below the knee may be used, but double uprights are preferable.

The same result may be accomplished by means of a light, firm spring attached to the ankle-joint of the brace, which automatically elevates the toes, and which the weight of the body in stepping readily overcomes. The same result may be obtained from elastic straps attached to the outer and inner sides of the toes of the shoe, crossed in front of the ankle, and buckled or fastened to the leg-band above. In all these appliances in which an ordinary shoe is used, a steel plate must be inserted between the leather of the sole during the making of the shoe, or an inside steel plate must be attached to the shoe when the brace is attached.

When varus coexists from the foot rolling inward from the weakness of the tendons about the ankle-joint, and the relaxation of the ligaments, a pad should be fastened to the outer ankle-joint of the apparatus, and a leather T-strap should be added to the outer side of the shoe, and buckled over the inner upright.

If, as is often the case, valgus is associated, this pad and T-strap should be attached to the inner side, and in addition a steel plantar spring, described under acquired club-foot, will afford additional support, and tend to invert the foot to its normal position. In many cases the T-strap may be dispensed with, and a strap of webbing may be attached to the outer upright just above the external malleolus.

When the thigh muscles are paralyzed the limb drops forward, and is unable to sustain the weight of the body. If, however, the limb be thrown backward from relaxation of the posterior ligaments, the limb furnishes some support, but "back-knee" results. For these conditions it is necessary to support the knee in a fully extended position. This is readily accomplished by carrying an outer and inner steel bar from the shank of the shoe to the upper part of the thigh, to be attached to a posterior steel band, and at the knee a broad leather band maintains the knee in position.

This is the principle upon which all paralysis leg braces are constructed, but for convenience in sitting they should be furnished with a lock or catch at the knee. For this purpose numerous catches are in use, of which the best

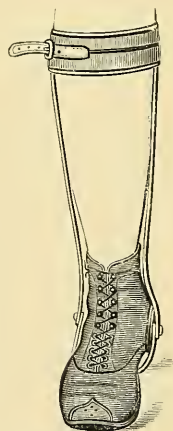


FIG. 452.—ANKLE SUPPORT FOR TALIPES VALGUS.

are the drop-catch and the Congden. The drop-catch consists of a simple ring which falls when the limb is extended, and may be raised with ease to permit flexion. The Congden consists of semicircular pieces of steel attached to the knee-joints on either side, into which the ends of a steel bow play in such a manner as to lock automatically when the limb is extended, but which, upon being slightly elevated, permits the knee to flex.

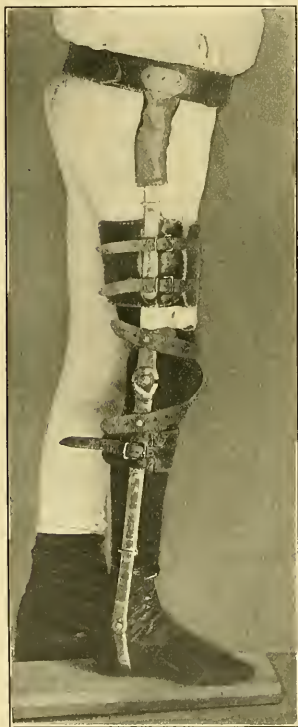


FIG. 453.—INFANTILE PARALYSIS BRACE.

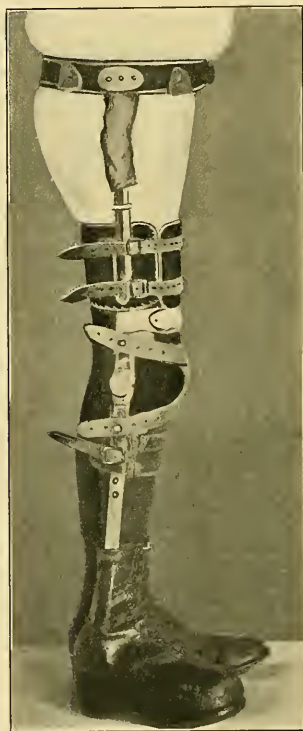


FIG. 454.—SAME, WITH EXTENSION SHOE.

To prevent hyperextension of the knee the knee-joints of the apparatus should have a stop-joint.

If the loss of power be not complete, the muscles may be assisted by elastic bands so attached to projecting bars as to supplement the palsied part, and the stop-joint or catch-joint is omitted.

Where contraction of the hamstring tendons produces deformity of the knee, this may be overcome by tenotomy.

A very useful brace for the correction of flexion of the knee from paralysis of the quadriceps extensor consists of an ordinary paralysis brace extending from the sole of the foot to the upper part of the thigh, to which at the knee-joints are attached semicircular plates attached to the lower upright, and perforated near the border so as to be altered by a screw to any angle. Pressure is applied by means of a leather knee-cap, provided with four straps closely perforated to fit the pins upon the lateral uprights. Instead of the semicircular pieces, a worm-screw and ratchet may be attached, and with a key the splint can be set at any angle.

Either of these braces should fit accurately, and this may be secured by broad leather bands above and below the knee, attached laterally to the brace and laced in front.

In many of these cases the affected limb will be found shorter than the sound one, and in applying the apparatus the length of the limbs must be equalized by applying an insole or a high cork patten to the shoe of the short side.

Paralysis of the lower extremity and trunk. In these cases, which without operation and apparatus are practically helpless, the entire body from the feet to the axillas must be made rigid, to support the weight while the body is swung forward upon crutches.

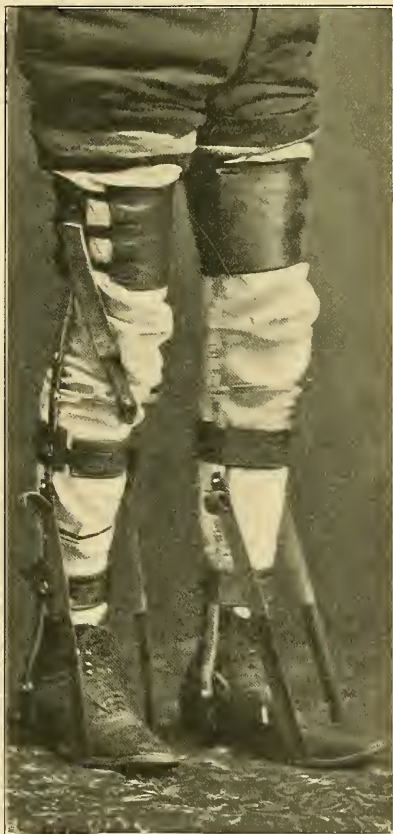


FIG. 455.—PARALYSIS BRACE WITH RUBBER MUSCLES.

The body may be incased in a leather jacket, or a steel framework may be made to encircle the trunk, and to this the leg appliances can be connected. To enable the patient to sit, locking and unlocking joints at the hips and knees are essential. If possible, crutches should be employed; but if these cannot be held securely, a steel-framed walking apparatus, a Darrach wheeled crutch, trolley suspension, or the wheeled crutch will be found useful.

These are simply light frames with wheels, the top of the framework being padded to fit under the axillas, and with straps or a padded piece of metal for the hands to hold. By such apparatus the unaffected muscles are

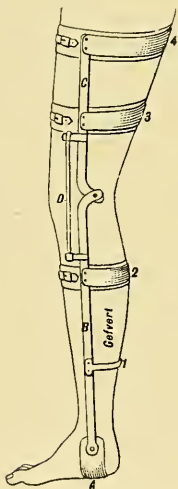


FIG. 456.—PARALYSIS BRACE FOR INFANTILE PARALYSIS.

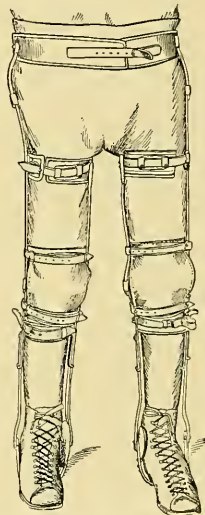


FIG. 457.—PARALYSIS BRACE.

exercised, and the weakened ones are also brought into use. The construction and use of these apparatus are well shown in the accompanying illustrations (Figs. 458 and 459) and need not here be described.

Paralysis of the trunk. Paralysis of the trunk muscles seldom occurs except in connection with extensive paralysis of one or both lower extremities.

Paralysis of the muscles of the back, when unilateral, gives rise to lateral curvature, and for its relief the mechanical appliance considered under the treatment of that affection can be employed. Bilateral paralysis renders the spine unable to maintain an erect position, and demands for its relief the use

of corsets of leather, wood, wire, etc., as employed in the treatment of Pott's disease of the spine. In these cases crutches, or wheeled crutches, or a couch, will be required for locomotive purposes.

Paralysis of the abdominal muscles gives rise to a marked lordosis, with a protuberant abdomen. In mild cases abdominal corsets or supports will relieve the deformity, and in severer cases a well-fitting leather jacket will be serviceable.

Paralysis of the upper extremity. The mechanical appliances used

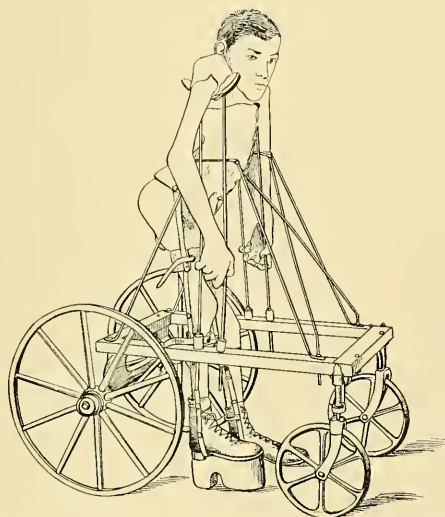


FIG. 458.—WHEEL CHAIR FOR INFANTILE PARALYSIS (Willard).



FIG. 459.—Trolley Suspension for INFANTILE PARALYSIS (Willard).

in paralysis of the deltoid to prevent further relaxation of the acromiohumeral ligaments consist of a well-padded leather breast-ring encircling the base of the neck, with a leather band for the forearm attached to it by straps. More complicated apparatus may be employed, consisting of a well-fitting shoulder-piece and elevating springs attached to an arm-band encircling the part. In some cases a simple handkerchief sling will answer every purpose.

In cases of wrist-drop elastic bands may be substituted for the paralyzed extensor muscles. If the flexor muscles become permanently contracted, tenotomy or transplantation of tendons must be performed.

Operative Treatment.—This is demanded when mechanical methods are inefficient or undesirable, and affords the most speedy and efficient result in the severest cases.

It includes (1) tenotomy, (2) tendon-shortening, (3) transplantation of muscles and tendons, (4) aponeurotomy, (5) myotomy, (6) neural anastomosis, (7) forcible straightening, (8) excision, (9) osteotomy, (10) arthrodesis,



FIG. 46c.—SPASTIC PARAPLEGIA BEFORE OPERATION.



FIG. 461.—SAME, AFTER OPERATION.

and (11) amputation. Several of these procedures may be combined in one operation.

The advantage of operative treatment is that it places the parts in condition for subsequent orthopedic treatment. Great vigilance should be exercised in performing operations upon cases of infantile palsy because of their low vitality and poor respiratory action. Especially should the urine be

examined carefully for acetone, since Bracket, Stone, and Low have recorded fatal cases attended by acetonuria. Acetonuria, if present before operation, in my opinion is regarded as a contraindication to operation. If it appears after operation, it is always to be regarded as a grave complication.

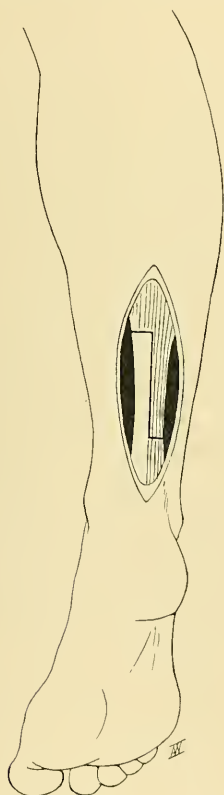


FIG. 462.—LENGTHENING OF THE TENDO ACHILLIS BY DIVIDING AND SLIPPING THE TWO HALVES OVER EACH OTHER (Berger and Banzet).

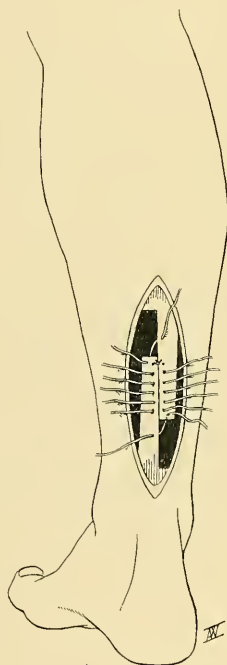


FIG. 463.—SUTURE OF THE TWO HALVES AFTER THE OPERATION OF LENGTHENING (Berger and Banzet).

1. Tenotomy. This may be performed subcutaneously or as an open incision, the latter being the only safe method where the deep structures about the hip or knee have to be divided. In either case the technic is the same as already given, and strict asepsis must be observed.

Immediate rectification should be accomplished, but over-correction is

not necessary here as in congenital deformities. Contraction of the hip will require division of the sartorius, long head of the rectus femoris, and tensor vaginae femoris, and by carefully avoiding the femoral artery and anterior

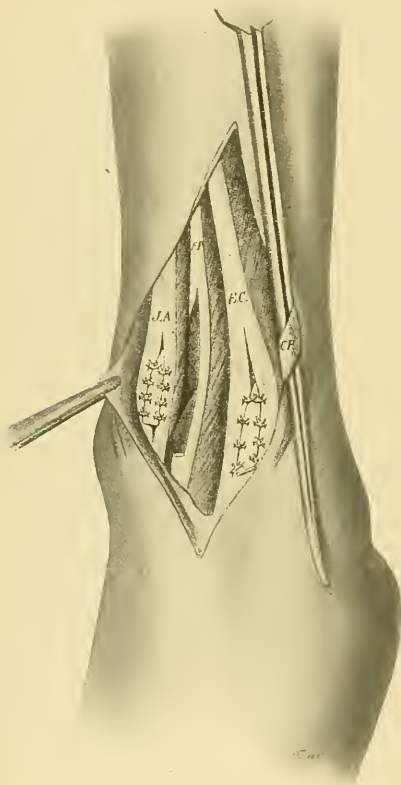


FIG. 464.—TRANSPANTATION OF THE FASCIA OF THE EXTENSOR OF THE GREAT TOE TO THE TENDON OF THE ANTERIOR LEG, OF THE FASCIA OF THE SHORT PERONEAL LATERAL TO THE COMMON EXTENSORS OF THE TOES.

E.P., Fascia of tendon of extensor proprius hallucis; *J.A.*, anterior aspect of leg; *C.P.*, peroneus brevis; *E.C.*, extensor communis digitorum.

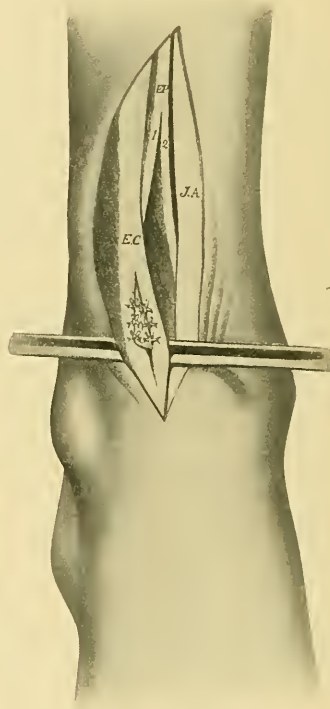


FIG. 465.—TRANSPANTATION OF A TENDINOUS FASCIA OF THE EXTENSOR OF THE GREAT TOE TO THE TENDON OF THE COMMON EXTENSOR.

E.C., Extensor communis digitorum; *E.P.*, 1, extensor proprius hallucis; *E.P.*, 2, sound portion of same; *J.A.*, anterior aspect of leg.

crural nerve these may often be accomplished subcutaneously. If the psoas, the capsule of the joint, and the external or internal rotators require division, a longitudinal open incision of considerable length will be necessary. The

adductors may be divided subcutaneously, when it is always advisable to have the skin puncture as far removed from the genitals as possible. This is accomplished by pulling the skin inward when the puncture is made. Subcutaneous section of the psoas, although it has been successfully accomplished, is not a safe operation, and is therefore best performed by open section. Injury necessitating ligation of the femoral artery has resulted from an attempt by Phelps to divide the psoas subcutaneously.

Contraction of the knee in severe cases will require tenotomy of the

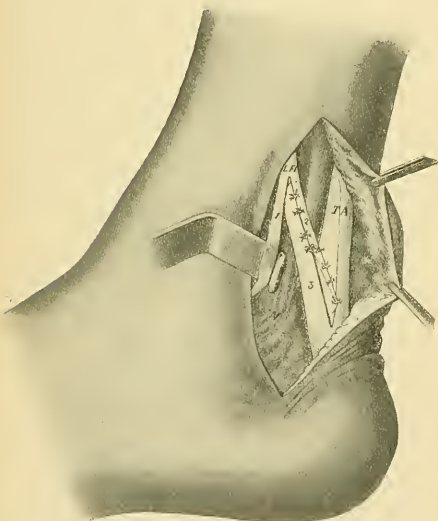


FIG. 466.—TRANSPLANTATION OF THE FASCIA OF THE LONG FLEXOR TO THE TENDO ACHILLIS (Berger and Banzet).
T.A, Tendo Achillis; L.Fl, long flexor; L.Fl, 1, sound portion of tendon of long flexor; 2, same divided; 3, fascia of tendo Achillis.

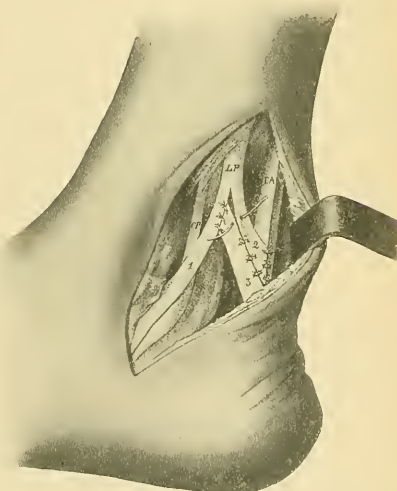


FIG. 467.—TRANSPLANTATION OF THE PERONEUS LONGUS TO THE TENDO ACHILLIS.
L.P, 1, Sound portion of peroneus longus; L.P, 2, fascia of tendon of peroneus longus; T.A, tendo Achillis; 3, fascia of tendo Achillis; C.P, tendon of peroneus brevis.

hamstring tendons, and in some instances this had best be accomplished by the open method, since the parts are often greatly distorted and it is difficult to distinguish the structures. In this manner the dense bands in the region of the popliteal space may more safely be divided.

2. Tendon shortening. For severe calcaneus, resection or shortening of the tendo Achillis is desirable, and the methods for its performance are fully described under paralytic club-foot. To avoid removal of any piece of tendon the method of Walsham and Willett is to be preferred. Where

the peroneals are intact, an excellent surgical procedure is to divide the tendo Achillis and sew the peronei tendons to it, so that the contraction of the peroneal tendons would elevate the heel.

3. Transplantation of muscles and tendons. Additional muscular power may be gained by transplanting a portion of the flexor proprius hallucis, which frequently escapes paralysis, as suggested by Berger and Banzet.



FIG. 468.—TENDON TRANSPLANTATION FOR INFANTILE PARALYSIS (Willard).



FIG. 469.—SAME, POSTERIOR VIEW.

In paralysis of the quadriceps extensor, transplantation of the biceps and semitendinosus tendons to the rectus femoris tendon has been found to be efficient. Or if not paralyzed, the tendon of the sartorius muscle may be similarly transplanted.

Where a condition of valgus is present, the extensor proprius hallucis can be attached to the tibialis anticus, or the peroneus tertius and part of the extensor communis digitorum may be attached to the tibialis anticus.



FIG. 470.—POLIOMYELITIS IN WOMAN OF THIRTY, WITH RIGHT-ANGLED ANKYLOSIS OF BOTH HIPS (Lange).



FIG. 471 —SAME, LATERAL VIEW (Lange).



FIG. 472.—POLIOMYELITIS IN A GIRL OF TWELVE, BEFORE OPERATION (Lange).



FIG. 473.—SAME, AFTER OPERATION (Lange).

It must be remembered that in performing all tendon transplantations, the success of the operation largely depends upon maintaining the proper amount of tension in the transplanted tendon.

4. Aponeurotomy of all contracted muscles will be demanded wherever they interfere with the correction of the deformity.

5. Myotomy. Resection of the quadriceps has been performed by Keetley for paralysis and stretching with contraction of the knee.

After operation for contraction about the knee, horizontal bed extension with constant pressure over the knee is beneficial. Tenotomy about the foot for deformity is fully described under paralytic club-foot. The tenotomies are best performed subcutaneously, except that of the posterior tibial, which is best divided by the open method. In talipes equino-varus the tibialis anticus, posticus, plantar fascia and ligaments will all require division. In talipes valgus the peroneals require division, an operation the writer strongly advocates and one to which sufficient attention has not been given by surgeons. Forcible rectification will also be serviceable after tenotomy.

6. Neural anastomosis. The operation of transplantation of nerves is especially adapted to selected cases of infantile palsy. The theory upon which this operation is founded depends upon the absence of paralysis in other centers the peripheral nerves from which are sufficiently near the paralyzed nerves to admit of the use of the sound centers through the anastomosis of the paralyzed nerves to those which are normal. The technic has already been described in Part I.

Anastomosis of branches of the anterior tibial with the musculocutaneous, and of the external and internal popliteal nerves, has been successfully performed by the writer, and Spitzzy has proposed an anastomosis of the obturator with the longer saphenous branch of the anterior crural nerve.

The future possibilities of this operation are as yet undetermined.

7. Forcible straightening. An extreme amount of force is sometimes required, and may be employed with safety if only the surgeon's hands or sand-bags be used. Fracture is to be avoided; but if it occurs it will heal readily and will not complicate the case.

8. Excision of the knee-joint or ankle-joint may be required on account of extreme deformity or in order to secure a stiff joint. In the poorer classes resection in preference to the application of apparatus may be seriously considered.

9. **Osteotomy** and **osteoclasts** have been found to be satisfactory in in-knee and out-knee.

10. **Arthrodesis.** Arthrodesis in order to secure a stiff joint is of greatest value in the ankle-joint, especially if associated with transplantation of tendons. The technic of the operation has already been described in Part I, and its application in paralytic calcaneus will be described under paralytic club-foot.

In severe cases of deformity about the ankle and foot, if resection of the tarsal bones becomes necessary, the removal of the astragalus is to be preferred to tarsectomy, and both are to be considered as last resorts, for in most cases powerful force will accomplish all that can be gained by operative methods.

11. **Amputation** will, in exceptional instances, become necessary.

Treatment after Operation.—The after-treatment will include bed extension and the thorough use of massage and electricity for a long period. After thorough correction by operative means mechanical appliances are often necessary. These are the same as have been fully described under the mechanical treatment of paralysis of the lower extremity and trunk. With these measures the most satisfactory results can be obtained, and a number of successful cases have been recorded, and the writer's experience has demonstrated the fact that there are very few cripples suffering from infantile spinal paralysis that cannot be helped by some such thorough surgical and mechanical treatment as that just described.

CHAPTER XIX.

INFANTILE CEREBRAL PALSIES.

The cerebral palsies in children consist of certain spastic palsies due to cerebral defect, with atrophy, usually slight, of the affected muscles, and without marked changes in electric reaction.

Although mentioned by Reil in 1812, the first accurate descriptions were given by Hensch in 1842, and by Little in 1853. Since this time numerous monographs have appeared and many valuable papers have been contributed.

Under the generic term cerebral palsies—the German *Cerebrale Kinderlähmung*—are included a large group of motor palsies, the result of a destructive lesion of the centers of the upper or *cortico-spinal* portion of the motor path, sharply defined in their clinical features from the palsy—the common infantile paralysis—due to a lesion of the lower or *spino-muscular* portion of the motor tract. The relative frequency of these two groups is estimated to be about 1 to 1.56.

The cerebral palsies are classified, according as the distribution of the paralysis is unilateral, bilateral, or paraplegic, into three groups: (1) Hemiplegia; (2) bilateral hemiplegia, or diplegia; and (3) paraplegia.

In 225 cases reported by Peterson and Sachs, the distribution was as follows: Right hemiplegia, 81; left, 75; diplegia, 39; paraplegia, 30.

In 150 cases collected by Osler, 120 were hemiplegic, 19 were diplegic, and 11 were paraplegic. The sexes are about equally affected. In Osler's 120 cases of hemiplegia, 57 were boys and 63 girls.

The age at which these different forms are most common is interesting. Of the hemiplegic cases two-thirds have their onset in the first three years of life, and a smaller proportion occurs at birth and a few only are prenatal. Thus, Freud has collected 594 cases, of which 76 cases were congenital, 162 were during first year, 139 second year, 81 third year, 36 fourth year, 10 fifth year, 75 sixth to tenth year. Of the diplegic cases the large majority date from birth as the result of injury. Of the paraplegic cases the majority are congenital, a small proportion only occurring within the first years of life.

Etiology.

The exact significance of many attendant or preceding diseases, and of environment and heredity, as etiologic factors is difficult to estimate. At best the etiology is obscure. Among the predisposing factors, however, may be mentioned consanguineous marriages, alcoholism either chronic or at time of conception, hereditary syphilis, and a certain family tendency to lesions of the nervous system and malnutrition. The exciting causes are usually divided into three classes according to the time of their occurrence: first, prenatal or intrauterine; second, natal or birth-palsies; and third, post-natal.

Among the prenatal causes the most important are traumatisms; serious maternal infections or septic diseases (in some of which cases the fetus may be simultaneously affected), such as typhoid, influenza, pneumonia, nephritis, endocarditis, and the exanthemata; developmental arrest in development of the brain, or deformity of the skull; and prematurity. In rare cases cerebral hemorrhage and softening from vessel occlusion may occur. Congenital hydrocephalus is rarely a cause because of the small percentage of survivals.

Of the natal causes, long, difficult, and instrumental labors, particularly in first-born children, are easily demonstrable. In some cases, however, precipitate labor may cause marked compression and asphyxiation. Asphyxia neonatorum is also a cause. The lesions produced by meningeal hemorrhage in birth injuries, as shown by McNutt, occur at the base of the brain in vertex presentations, and on the convexity in breech. Mechanical obstacles on the part of the mother, such as produce great compression in the superior strait, and asphyxia from long labor, are far more important causes than the use of instruments, which may, in fact, sometimes prevent the occurrence of cerebral hemorrhage.

Of the post-natal causes, the post-febrile processes of infectious and other diseases, such as diphtheria, scarlet fever, variola, vaccinia, and varicella, measles, mumps, whooping-cough, tonsillitis and gastro-enteritis, typhus, typhoid, dysentery, cerebrospinal fever, influenza, etc., are the most important. In whooping-cough and violent vomiting cerebral hemorrhage may occur. Hydrocephalus, and focal polioencephalitis, are also causes. Traumatisms are comparatively common causes. Thrombosis at times occurs in endocarditis and other ulcerative conditions; and hemorrhage from syphilitic endarteritis is the most common syphilitic lesion. While the majority of the diplegic cases will be found to be syphilitic, but few of the hemiplegic arise from this cause. Sachs and Osler both believe that in rare cases convulsions

may give rise to hemiplegias and diplegias; such as the occurrence of cerebral hemorrhage as the result of severe peripheral irritation in dentition or toxemias.

Of the congenital cases, fright and strong emotion during pregnancy and premature delivery, especially at the seventh month, deserve especial prominence. The same may be said of traumas, particularly cerebral hemorrhages in birth palsies, and the influence of the infectious diseases in the palsies coming on during the first years of life.

Infantile Hemiplegia.

Synonyms.—*English*, Spastic Paralysis. *French*, Agénésie Cérébrale; Sclérose Cérébrale; Atrophie Partielle Cérébrale. *German*, Hemiplegia Spastica Infantiles; Hemiplegia Spastica Cerebralis; Akut Encephalitis der Kinder; Atrophische Cerebrallähmung. *Italian*, Paralisi spastica; Emiplegia spastica infantile. *Spanish*, Hemiplegia infantile.

Symptomatology.—There is often present before the onset of paralysis a slight febrile attack, infectious or otherwise, an acute attack resembling indigestion, or a history of a fall or blow on the head. The onset is usually characterized by a series of convulsions and coma, though the disease may develop suddenly in apparently perfectly healthy children without spasms or loss of consciousness, or may develop insidiously without disturbance of any kind. Again, the onset may be accompanied by delirium or screaming-spells. A latent gradual onset is most common.

The paralysis affects the sexes about equally; thus, of 692 cases recorded by Freud, 374 were on the right side and 318 were on the left side.

The convulsions are almost always accompanied by loss of consciousness, lasting from a few hours to many days. Fever, transient or persisting for weeks, is present in a large proportion of cases. Vomiting and general hyperesthesia are sometimes observed. When consciousness is recovered, the hemiplegia is usually complete; but occasionally loss of power, at first not complete, gradually becomes so. In about one-half the cases the face is paralyzed, and in these it is not complete, and rapid and complete disappearance is the rule.

The arm is more severely affected than the leg, recovers more slowly, and rarely recovers the more delicate movements. Arrest of development may occur, but a moderate degree of atrophy is usual. The leg, at first powerless, recovers more rapidly and more completely. Arrest of development is rare, and atrophy is never so marked as in the arms. The paralyzed arm and leg

may remain flaccid for ever, but rigidity is present in the large proportion of cases, and comes on at a variable period after the onset. The rigidity is increased by emotion or by attempts to use the limb or forcibly overcome the spasm, and disappears during sleep and under anesthesia.



FIG. 474.—CEREBRAL HEMIPLEGIA.

During voluntary movements the rigidity has associated with it ataxic and choreiform movements, and choreiform movements, athetoid movements, and tremors may occur involuntarily.

The reflexes are usually increased, sensation is often unaffected, and vascular sluggishness is marked by coldness and blueness of the skin in severe cases. The electric reactions remain practically unaffected.

Hemianesthesia occurs, but may not attract attention on account of the youth of the patient. Hemianopia is frequently present and may lead to torticollis.

Aphasia is observed in about one-third of all the cases; in some transitory, in others persistent. Post-hemiplegic movements in a certain proportion of cases—about one-fifth—follow at a later stage. These have been referred to by different observers as post-hemiplegic tremor, post-hemiplegic chorea, mobile spasm, athetosis, hemiataxia, and chorea spastica.

These consist of convulsive movements of the affected parts, incoordinate and choreiform in character. Mental defects, from complete idiocy to a feeble-minded condition, are frequently found associated with infantile hemiplegia, and three grades may be distinguished: idiocy, imbecility, and slight backwardness. The lesser degree of mental defect is met with in the majority of

cases. Of 26 cases recorded by Bradford and Lovett, only 6 had what was classed as average intelligence; in Gaudard's 80 cases 15 were feeble-minded and 19 idiotic children; in Wallenberg's 160 there were 50 with mental defects, and in 15 more imbecility followed the epilepsy; while in Osler's 120 cases only 12 of the infirmity series had idiocy or imbecility at the time of observation; and all of the 23 cases at the Pennsylvania Institute for Feeble-Minded Children had some degree of idiocy or imbecility.

Epilepsy, at first confined to the paralyzed side, but tending to become generalized, attacks sooner or later a considerable proportion, from a quarter to a half of all the cases. The most common form is the true Jacksonian epilepsy.

Post-hemiplegic contractions of a permanent nature are most marked in the upper extremity. In severe cases the arm is held to the side, the elbow flexed and semi-pronated, the hand flexed, and the fingers contracted upon and embracing the thumb in the palm of the hand. The thigh is flexed and adducted at the hip, the knee flexed and rigid, and the foot held in a position of equinus or equinovarus. These contractures are, moreover, very firm and resistant.

Bilateral Spastic Hemiplegia.

Synonyms.—*English*, Spastic Rigidity; Spastic Rigidity of the Newborn; Spastic Paralysis of Children; Tonic Contraction of Extremities; Spastic Diplegia; Essential Contraction. *French*, Spasme Musculaire Idiopathique. *German*, Permanenter Kinder-Tetanus. *Italian*, Malo de Little; Spasimo musculare idiopatico dei bambini. *Spanish*, Hemiplegia spástica bilateral. In France the disease is sometimes spoken of as Little's disease (*maladie de Little*), and Gowers has applied the name birth palsies, since in the large proportion the trouble dates from birth.

Symptomatology.—Bilateral hemiplegia is characterized by spastic condition of the extremities. This is observed immediately after or shortly succeeding birth, but occasionally it follows convulsions in one of the specific fevers.

The arms may be but slightly affected. The legs are rigidly extended, and the thighs firmly adducted—the so-called “clasp-knife rigidity”; the feet are crossed and in a varus or equino-varus position.

On attempting to walk, the gait is awkward or movement is impossible. The arms are flexed and held firmly to the sides, and the use of the hands is

extremely awkward. The extremities are not atrophied. Sensation is unimpaired, the reflexes are increased, and the electric reactions are unchanged.

Three types of attitudes have been described by Taylor ("Nervous Dis-

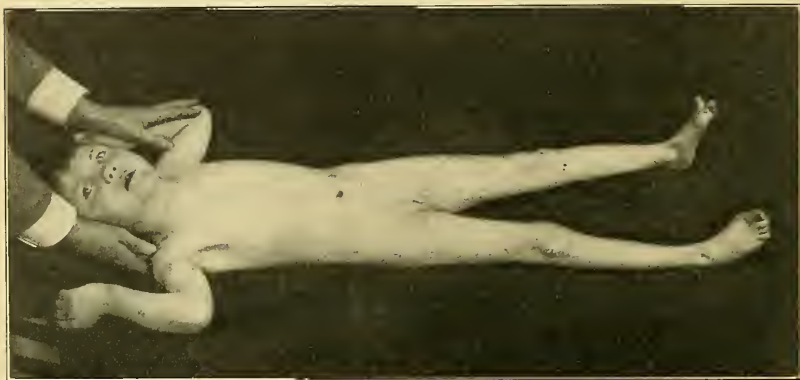


FIG. 475.—CONGENITAL DIPLEGIA. EARLY STAGE.



FIG. 476.—CONGENITAL DIPLEGIA. LATE STAGE. LEFT FOOT TALIPES CAVUS.

eases in Childhood," 1905)—the cramped attitude, the attitude of adoration, and the extension-supination position.

Spasm of the affected parts with disordered movement, and variously described as *chorea spastica* and *double athetosis*, is not uncommon, and the

so-called congenital chorea is only another name for the same symptom. Spasm of the muscles of the face and tongue is sometimes observed. Strabismus and nystagmus exist in some instances. The mental condition is seriously impaired, the patients being usually imbeciles or idiots. In some instances, however, intelligence is fair. Microcephalus, with or without asymmetry, is common. The facial expression is vacant, the teeth are defective, and dribbling from the mouth is constant.

Epilepsy is not so frequent as in hemiplegia.

Spastic Paraplegia.

Synonyms.—*English*, Tetanoid Pseudo-paraplegia; Deformity with Rigid Muscles; Spastic Spinal Paralysis; Spastic Contractions; Permanent Tetanus of the Extremities. *French*, Tabes Dorsalis Spasmodique. *German*, Para-



FIG. 477.—PHOTOGRAPH OF CASE OF CEREBRAL PALSY, SHOWING SPASTIC CONTRACTIONS OF UPPER AND LOWER EXTREMITIES.

plegia Cerebralis Spastica. *Italian*, Spasimo tabetico; Paralisi spinale spastica. *Spanish*, Paraplegia spástica.

Symptomatology.—In children the condition usually appears at birth, or within the first year, although it may occur later. The lower limbs are drawn by the strongest muscles into a condition of spasmodic rigidity, the thighs flexed upon the pelvis and slightly adducted, producing the “clasp-knife rigidity,” the knees flexed and firmly adducted, so that they touch, or even overlap, the feet inverted and strongly extended in a position of extreme equinovarus. The contractions readily yield to firm, continuous manual pressure like a bit of lead,—“lead pipe contraction,”—but immediately return upon its removal. The child stands with assistance, resting upon the ball of the foot and toes, and walks, if at all, with a rapid, swinging, irregular gait, typical of the disease, and with the knees overlapping at every step, the so-called cross-

legged progression. The feet drag, wearing out the shoe caps, and the clothing at the inner side of the knees is worn by constant friction. This stiffness is usually first discovered by the mother in washing and dressing the child, and the child is usually late and awkward in attempting to walk. There is usually

no anesthesia, ataxia, atrophy, or any vesical or rectal incontinence. There is no loss of equilibrium in standing with the eyes closed, and the reflexes are exaggerated.

In the upper extremity the same condition exists, but to a less degree. The arms are approximated to the side, the forearm slightly flexed, and the hands flexed and pronated. The flexors of the trunk are sometimes contracted, and the head may be drawn forward and to one side, as in wry-neck. Strabismus may occur early, and occasionally persist. The configuration of the head at times resembles that of the idiot, and with the half-silly, vacant stare, and an imperfect speech, presents the appearance of a lack of intelligence which does not always exist. In fact, in spastic paraplegia the cerebrum is less profoundly af-



FIG. 478.—SPASTIC PARALYSIS. LITTLE'S DISEASE (Lange).

affected than in either of the other two forms, and some patients are intelligent and bright intellectually.

Cerebral Palsies.

Pathology.—The pathologic lesions are so variable, and the subject itself is so extensive, that it is only possible in this connection to give a résumé of

the most recent matter. The pathology of infantile hemiplegia and diplegia has received much attention, but the morbid lesion in paraplegia remains at present less extensively studied. The morbid lesions in all three forms differ mainly only in localization, and are: first, from defective development, either of the neurons themselves or the brain tissue locally or generally; second, atrophy and retarded development, with subsequent descent of the degeneration through the pyramidal tracts and lateral columns; and, third, a destructive process in some portion of the motor tract of the cortico-spinal segment. In general, it may be asserted that the prenatal cases are in most



FIG. 479.—CEREBRAL PALSY. CONTRACTURE OF FOOT.

instances thrombotic in origin from endarteritis, those occurring at birth are the result of traumatism, and those occurring later in life are from encephalitis.

In infantile hemiplegia. From a study of ninety autopsies, his own and abstracted from various sources, in cases occurring in infancy or childhood, Osler has grouped the lesions which occur under three headings:

1. Embolism, thrombosis, and hemorrhage.
2. Atrophy and sclerosis.
3. Porencephalus.

There were sixteen of the first, fifty of the second, and twenty-four of the third group. Atrophy with induration, either of groups of convolutions, or an entire hemisphere, was noted variously distributed over the cerebral cortex, and in all the recent cases a descending degeneration of the pyramidal tract was found. Audrey also found that in 103 cases of porencephalus there were

hemiplegic symptoms in 68. Out of 78 cases of infantile hemiplegia collected by Sachs and Peterson, 23 presented hemorrhagic lesions, seven embolism, and five thrombosis. These were all of birth or post-natal origin. The primary cause in the majority of cases presenting sclerotic changes and porencephalia is unknown. Porencephalia may be the result of a congenital lack of development, or may be the result of an initial lesion long past and originally a hemorrhage.

Plugging of the sylvian artery, usually embolic, occurred in seven, and hemorrhage in nine. Atrophy with induration, either of groups of convolutions, a lobe, or an entire hemisphere, was noted variously distributed over the cerebral cortex, and in all the recent cases a descending degeneration of the pyramidal tract was found. Porencephalus, meaning literally "a hole in the brain," represents a loss of substance of variable size, from a few convolutions to half a hemisphere, in the form of cysts or cavities full of liquid, and clots, cerebral hypertrophy or atrophy, undersized and irregularly marked brain, agenesis corticalis of Sachs (in which all strata and layers of the cortex may be absent largely and especially the layer of great pyramidal cells), macrogyria, or softened and hemorrhagic areas with torn vessels, round-cell infiltration, granular cells and nuclear proliferation the result of a focal or diffuse encephalitis following traumatism.

These lesions represent the final results of initial processes long past and originally a hemorrhage, an encephalitis, or other post-febrile change. In birth palsies the main lesion is hemorrhage, which is rarely intra-cerebral, but generally meningeal. The later conditions show: meningo-encephalitis chronica; sclerotic or cystic changes; and partial atrophic changes. In the acquired or post-natal palsies are: (1) hemorrhage from traumatism or congestion during violent convulsions or a paroxysm of whooping-cough; (2) embolism from endocarditis or post-febrile causes; (3) other post-febrile causes, such as endo-arterial and peri-arterial changes and encephalitis; and (4) thrombosis of the cerebral veins caused by diseased and roughened vessels (mainly syphilitic), very weak heart action, and the blood in specific febrile diseases.

It has been suggested by Strümpell that the lesion was the cerebral counterpart of infantile spinal palsy—a *poliencephalitis* of the motor areas of the cortex, analogous to poliomyelitis of the anterior horns—a very suggestive theory, but one which has not been confirmed by the pathologic findings, nor has it met with the favor it deserves from neurologists, since anatomical proof is lacking.

It is probable that infantile hemiplegia is the result of a variety of different processes, of which the following, according to Osler, are the most important:

1. Hemorrhage, occurring during violent convulsions or during a paroxysm of whooping-cough.
2. Post-febrile processes: (a) embolic; (b) endo-arterial and peri-arterial changes; and (c) encephalitis.
3. Thrombosis of the cerebral veins.

In bilateral spastic hemiplegia, which is usually the result of a birth palsy, the pathologic lesion is in all probability bilateral atrophy, sclerosis, or porencephalous defect of the motor areas of the cortex cerebri.

In the reports of numerous autopsies this is the lesion usually observed, and, in many, descending degeneration in the pyramidal tracts has been found.

In infantile spastic paraplegia the pathologic lesion involves the pyramidal tracts and is generally the extension of a cortical lesion. It is not improbable that some cases may be due to spinal hemorrhage, and that traction in feet presentation might injure the pyramidal tracts and be followed by sclerosis, or that it might result from injury inflicted upon the medulla during efforts at resuscitation.

In the one recorded autopsy, that of Förster, the cord changes were regarded as a descending degeneration, the consequence of cerebral lesion. The most plausible view is that the lesion, originally cerebral, has more or less completely disappeared and left the secondary descending degenerative cord-changes as the most conspicuous feature. It has also been ascribed to primary sclerosis of the lateral columns (crossed pyramidal column), to various lesions of the spinal cord, chiefly myelitis, meningitis, micro-cephalia, porencephalia, and anencephalia, and to genital or other peripheral irritation.

Diagnosis.—The characteristic signs of this group of cases are the spastic tetanoid condition of the extremities, the distribution of the motor paralysis, the absence of atrophy in the affected parts, with increased reflexes, and unchanged electric reactions, with or without mental defect. These form a comprehensive picture that can scarcely be mistaken for any other affection except idiocy uncomplicated by spastic paraplegia. In this condition there is a relaxed, flaccid condition of the muscles, the child sits and stands with difficulty, and there are absent both localized paralysis and muscular rigidity.

Differential Diagnosis.—From infantile spinal paralysis, with which

it is most frequently confounded, cerebral paralysis has been very carefully differentiated in the preceding chapter.

In infantile spinal paralysis the sudden paralysis is accompanied by early loss of reflexes, absence of rigidity, and marked electric reaction changes, while in the infantile cerebral palsies the paralysis is accompanied with spasm and disordered movements, increased reflexes, gradual and slight wasting, and normal electric reactions.

The hemiplegia must also be distinguished from obstetric paralysis, cerebral tumor, and the diplegia and paraplegia from pseudo-paralytic rigidity met in children.

Cerebral tumors sometimes produce symptoms identical with cerebral palsies and ordinarily cannot be distinguished.

Obstetric paralysis of the face or upper extremity from forceps injury is a peripheral lesion and need not be confounded with palsies of cerebral origin.

Pseudo-paralytic rigidity, described also as idiopathic contraction with rigidity, and tonic rigidity of the extremities, is apt to be confounded with true spastic paralysis. The fact that it is a painful carpo-pedal spasm, intermittent, transitory, often confined to the hands and arms, and associated with rickets or other constitutional disturbance, would serve to distinguish it.

Spastic paraplegia in a mild form sometimes resembles beginning pseudo-hypertrophic paralysis, and in such cases time alone can settle the diagnosis. Diplegic cases are sometimes confounded with grave hysteric conditions, but the administration of an anesthetic will cause a complete disappearance of all spasticity in the latter condition.

Prognosis.—The prognosis will depend much upon the character and extent of the initial lesion, hemorrhage and vascular obstruction being more favorable than meningo-encephalitis, and the latter than intracranial growths.

In the traumatic cases it should not be forgotten that complete spontaneous recovery sometimes occurs.

In intracranial growths surgical interference offers a bright prospect for cure, the success of the operation depending largely upon the character of the growth—infiltrating or noninfiltrating—and its accessibility. Many brilliant successes have been reported.

In regard to the bodily defect, while great improvement may be predicted, perfect recovery is rarely attained. Facial paralysis and aphasia usually disappear. Post-hemiplegic movements and epilepsy are bad prognostic signs.

In hemiplegic and diplegic cases the mental enfeeblement is distressing and grave, and while training may do much to improve, the prognosis for many is bad, since they are liable late in life to become the subjects of psychoses. Many of these children live to be over twenty years of age. In spastic paraplegia, while perfect recovery is impossible, most children learn to walk and talk imperfectly, and operative interference is of great value, for, as my own operations have demonstrated, tenotomy not only improves the position of the limbs, but also decidedly benefits the mental condition.

While the prospects of life are good, the vital resistance is not great, and there is a greater liability to death from intercurrent affections, and, according to some authorities, all cases of cerebral palsy are particularly liable to fatal meningitis.

Treatment.—The convulsions and coma which characterize the onset require the same general treatment as convulsions from other causes—a hot bath with cold to the head, a calomel purge, and bromids and chloral. After the paralysis is established the indications are to favor the natural tendency



FIG. 480.—CEREBRAL PALSY, DIPLEGIC TYPE, SHOWING CONTRACTION OF ARM BEFORE TENDON-LENGTHENING.



FIG. 481.—SAME, AFTER TENDON-LENGTHENING.

to improve, to maintain the nutrition of the palsied parts, and correct the deformities by proper surgical and mechanical measures. Daily massage, warm clothing, and electricity will be of great benefit in maintaining the nutrition and temperature of the affected parts. Gymnastic exercises will be found of great value, and Fraenkel exercises are quite as

valuable for children as for adult ataxics. The coordination may be developed by the use of bells, letter cards, etc., and the writer has found these means of great service. The electricity must be applied faithfully and

persistently for a long period. For the spastic rigidity and contractures, persistent massage with strong flexion and extension of the extremities is beneficial.

Circumcision may be of service where genital irritation is evidenced by balanitis, painful micturition, and frequent erections. In a certain number of cases, however, it has no effect whatever, or is only temporarily beneficial.



FIG. 482.—INFANTILE SPINAL PALSY BEFORE OPERATION.



FIG. 483.—SAME, AFTER OPERATION.

Tenotomy and tenoplasty offer the greatest hope in these cases. In diplegia little will be gained by operation, but in hemiplegia and paraplegia and in the post-hemiplegic contractions following, great benefit will ensue. The tendons that require division most frequently are the tendo Achillis, adductors of foot, hamstring, and adductors of the thigh. They should be

performed as described in Part I. After the operation the parts should be immediately over-corrected and fixed. No attempt need be made to straighten the contracted parts by mechanical stretching, but tenotomy may be at once resorted to, since, as before remarked, the effect upon the mental condition is also beneficial. After operation an

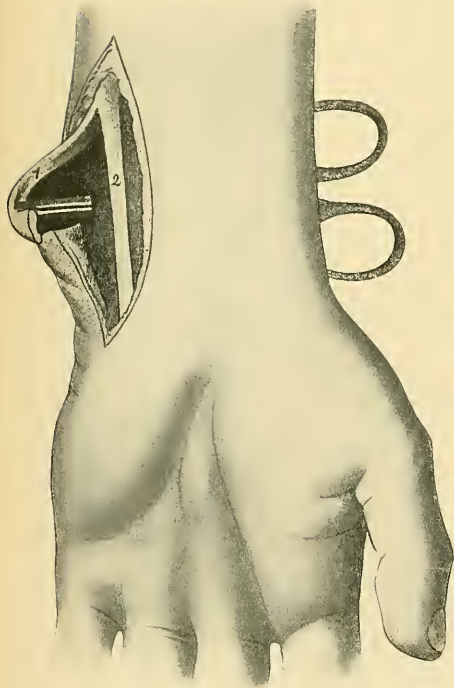


FIG. 484.—ACTIVE TRANSPLANTATION OF A PORTION OF THE FLEXOR CARPI RADIALIS TENDON TO THE EXTENSOR COMMUNIS DIGITORUM.

1, Portion of tendon of the flexor carpi radialis; 2, tendon of the flexor carpi radialis (Berger and Banzet).

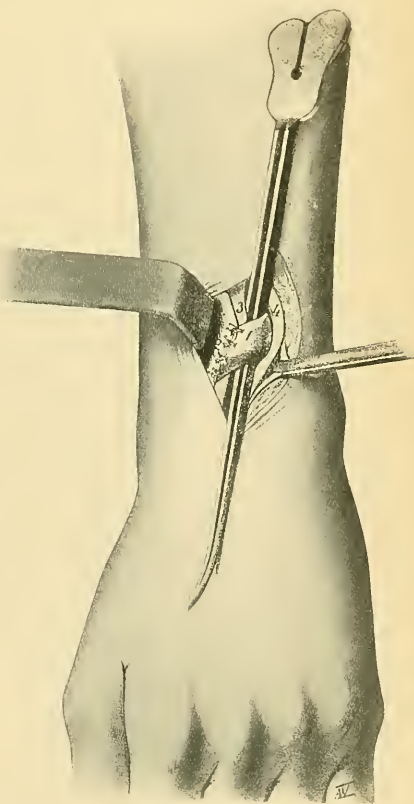


FIG. 485.—SUTURE OF THE FLEXOR CARPI RADIALIS TO THE EXTENSOR COMMUNIS DIGITORUM.

1, Tendon of the flexor carpi radialis; 2 and 3, tendons of the extensor communis digitorum; 4, tendon of the extensor minimi digiti.

ordinary varus walking-shoe with stop-joints at the ankle, or a Congden apparatus extending above the knee, with locking and unlocking joint to fix the knee, should be worn for some time, after which it may be permanently discarded.

Tendon grafting has a limited application in hemiplegia, the operation

of Hoffa being beneficial in selected cases. This consists in detaching the head of the pronator radii teres from its origin on the internal condyle and attaching it to the external condyle of the humerus. Then the flexor carpi ulnaris and flexor carpi radialis are detached from their insertions and attached to the tendons of the extensor communis digitorum. In this way the supination and extension of the hand are improved.

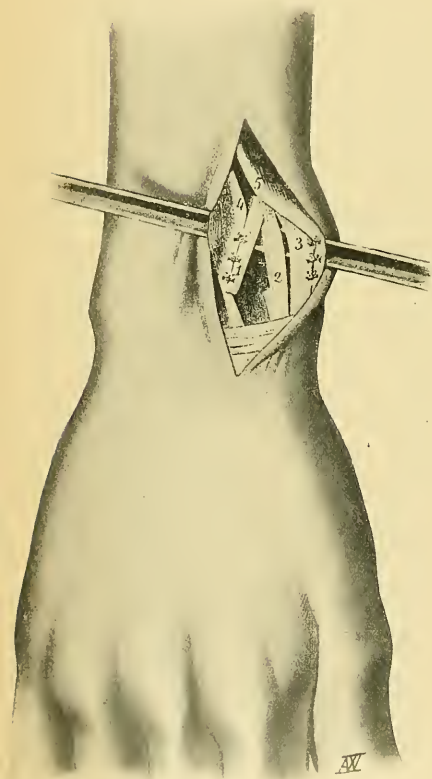


FIG. 486.—SUTURE OF THE RADIAL TENDONS TO THE ABDUCTORS AND THE EXTENSORS OF THE THUMB.

- 1, Portion of the extensor carpi radialis brevis; 2, tendon of the extensor carpi radialis longior; 3, tendon of the extensor carpi radialis longior; 4, tendon of the extensor longus pollicis; 5, tendon of the extensor brevis pollicis (Berger and Banzet).

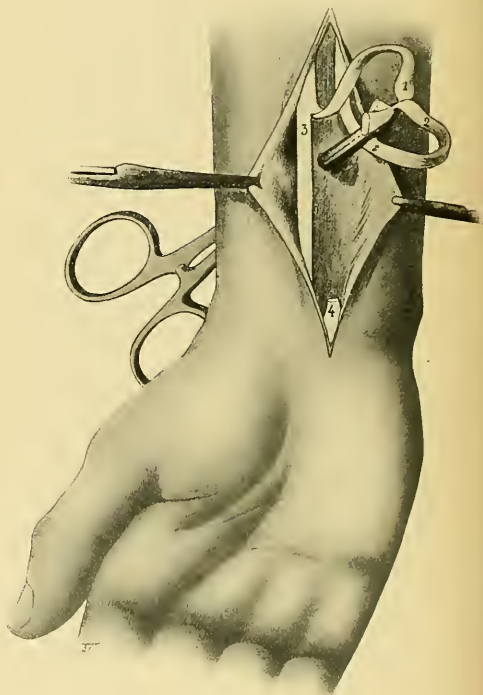


FIG. 487.—TRANSPLANTATION OF THE LARGE AND SMALL PALMAR TENDONS TO THE EXTENSORS OF THE FINGERS.

- 1, Internal half of the palmaris longus; 2, tendon of the palmaris brevis; 3, palmaris longus; 4, insertion of the palmaris brevis (Berger and Banzet).

The final result in tendon transplantation depends somewhat upon the condition for which it was performed. If the mental intelligence be high, the functional result will be better than if the mental condition were of low grade.

A successful nerve anastomosis for athetosis has been proposed by Spiller, and performed by Van Kathoden. It consisted in anastomosing all the divisions of the brachial plexus except the musculospiral.

The mental condition requires special training in all these cases, and the results attained at institutions specially devoted to the training of feeble-minded children demonstrate the advantages of such training in these particular cases. Such training should always be under

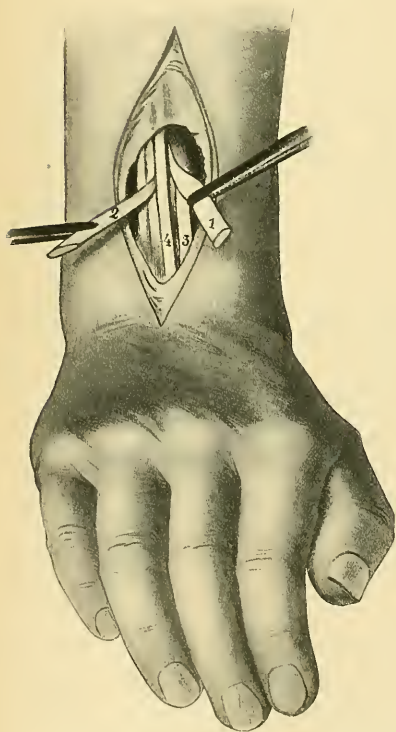


FIG. 488.—TRANSPLANTATION OF THE LARGE AND SMALL PALMAR TENDONS TO THE EXTENSORS OF THE FINGERS.

1, Internal fascia of the palmaris longus; 2, tendon of the palmaris brevis; 3, extensor indicis; 4, extensor communis digitorum (Berger and Banzet).

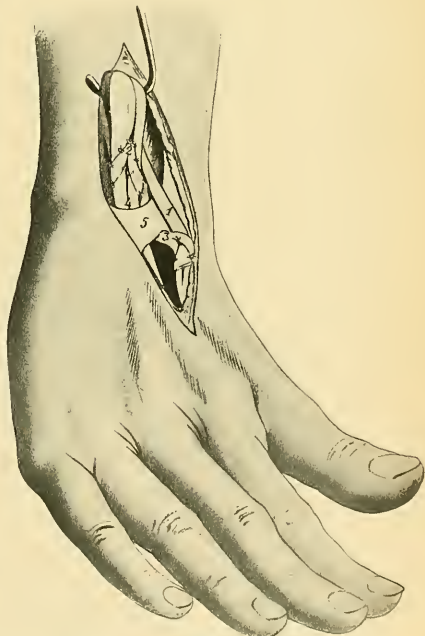


FIG. 489.—TRANSPLANTATION OF THE LARGE AND SMALL PALMAR TENDONS TO THE EXTENSORS OF THE FINGERS.

1, Tendon of the palmaris longus; 2, tendon of the palmaris brevis; 3, extensor longus pollicis; 4, extensor indicis (Berger and Banzet).

the direction of a competent specialist. The development of the mind through manual training is valuable, as by the Sloyd system. Similar good results have been obtained by the Allan Latshaw method, which aims first to attract the attention of the individual through the perceptive faculties, and afterward to

develop coordination through manual employment. Model farm scenes, pleasure grounds, etc., are used to interest the child, and subsequently he is taught the manufacture of objects seen, and finally manual training is added.

Operations on the brain for the relief of epilepsy in cases of cerebral palsy have of late been rendered possible wherever localizing symptoms have been present. Since the majority of cases are due either to (1) destructive vascular lesion, apoplectic, embolic, or thrombotic, (2) sclerosis, or (3) porencephalus, all of which are beyond relief from surgical interference, there remains nothing but the intracranial growths, the prognosis of which has already been referred to.

In long-standing cases the possible existence of descending degeneration offers a serious objection, since the paralysis could not be benefited by operation. Surgical interference will be found useless in the majority of cases of cerebral paralysis, and when porencephalus is present, the paralysis due to a hole in the brain is not likely to be improved by operation, convulsions and death usually resulting when such attempts are made. In my opinion, craniotomy is justifiable in cerebral hemiplegia in the event of the development of severe Jacksonian epilepsy in early life uninfluenced by the advent of puberty.

Craniectomy and asexualization. The theory that microcephalic idiocy is due to the premature ossification of the cranial sutures and a consequent arrest of cerebral growth has led to the operation of craniectomy, or the removal of a portion of the skull, for its relief. In the great number of cases which have been subjected to this operation the mortality has been as high as 25 per cent., the improvement in the other cases being either very slow and gradual or altogether absent. In a dozen cases operated upon before coming to him, Barr noted no improvement that could be traced to the operation, but rather found them mentally inferior to many in their class. Most authorities now agree that this theory is untenable, and that the size of the skull is determined by the growth of the brain, rather than the reverse, and that the development of an undersized brain cannot be influenced by craniectomy.

In order to prevent the inheritance of idiocy and to protect the public, asexualization has been proposed, and in certain states, as Connecticut, has been legalized. This is best accomplished by the performance of oophorectomy in the female, and of castration or vasectomy in the male, these operations



FIG. 490.



FIG. 491.



FIG. 492.

FIGS. 490-492.—ARTICLES MADE BY DEFECTIVE CHILDREN.



FIG. 493.

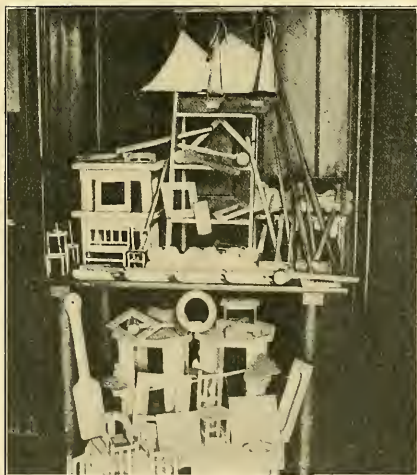


FIG. 494.

FIGS. 493-494.—ARTICLES MADE BY DEFECTIVE CHILDREN.

being performed only on low-grade idiots, and then only after the deliberate decision of a board composed of competent medical men and laymen. Ford reports 26 cases of asexualization in the male in which the effect upon the epilepsy was favorable, and Pfeister reports 116 upon whom oophdrectomy was performed; the menopause followed in 94.8 per cent.; sexual desire was abolished in 52 per cent., diminished in 30 per cent., and unaffected in 26 per cent.

Amaurotic Family Idiocy.

Sachs was the first to report this condition, which is mainly remarkable because of its restriction to children born of Jewish parents, and for the fact



FIG. 495.

FIG. 496.

FIG. 497.

FIGS. 495, 496, 497.—CRANIECTOMY FOR CEREBRAL PALSY (Barr).

that the onset usually occurs within the fourth to the eighteenth month. The children are usually healthy and their growth is normal until the time of onset, when they become stupid, weak, and of diminished muscular power. Their condition gradually becomes worse, and blindness due to optic atrophy completes the clinical picture. The ophthalmoscopic appearance is not, strictly speaking, that of pronounced atrophy, but the fovea centralis "presents a clear-cut liver-colored plaque surrounded by a halo of grayish-white which does not

obscure the retinal vessels." Death usually supervenes before the second year.

Two or more children in one family have been attacked with this disease, but normal children may be born to the parents between those affected.

Sachs gives as the pathologic change an agenesis and degeneration of the gray matter and even of the root ganglia throughout the entire cerebral axis. Frey, however, considers this disease as equivalent to amyotrophic lateral sclerosis in the adult.

CHAPTER XX.

OTHER PARALYSES.

There are four other motor affections for which the orthopedic surgeon is frequently consulted, and which deserve brief notice here. These are:

1. Pseudo-hypertrophic muscular paralysis.
2. Progressive muscular atrophy.
3. Hereditary ataxia (Friedreich's disease).
4. Peripheral palsies.

The first two of these are known as muscular dystrophies, and Gowers has designated the congenital forms "muscular abiotrophy" to indicate the premature senility of the muscles.

The nerve tract last developed and the muscles least used suffer most, illustrating the preservation of the essentials.

Pseudo-hypertrophic Muscular Paralysis.

Pseudo-hypertrophic muscular paralysis is an affection of childhood, characterized by an abnormal increase in the size of certain muscles with diminution in the size of others.

Synonyms.—*English*, Duchenne's Paralysis; Muscular Pseudo-hypertrophy; Lipomatous Muscular Atrophy; Diffuse Muscular Lipomatosis. *French*, Paralyse Myosclérosique; Paralyse Musculaire Pseudo-hypertrophique. *German*, Lipomatosis Luxurians Muscularis Progressiva; Myopachynsis Lipomatosa. *Italian*, Paralisi pseudo-ipertrofica muscolare; Paralisi di Duchenne; Cifomatosi muscolare diffusa. *Spanish*, Parálisis pseudohipertrofica Muscular.

Etiology.—The etiology is obscure. It usually appears between the ages of two and eight, and affects males more frequently than females in the proportion of about four or five males to one female. Congenital cases occur, and in rare cases this disease occurs as late as puberty. Cases have been known to occur as late as eighteen or twenty years. Heredity is an important factor, the morbid inheritance being usually maternal, and it is more apt to occur in families than in isolated cases.

The appearance of the disease in several members of the family in either one or more generations; the fact that the disease may not always appear as pseudo-hypertrophic paralysis, but in some cases alternates with the other muscular dystrophies; the transmission through the maternal line; and its appearance during the age of growth and development mark it as being hereditary, "familial," and congenital.



FIG. 498.—PHOTOGRAPH OF CASE OF PSEUDO-HYPERTROPHIC MUSCULAR PARALYSIS. EARLY STAGE.

The disease is transmitted mainly through the female members of the family. Coming, as it does, during childhood, it has in some few instances seemed to have followed some one of the disorders of that period, but this perhaps may be accidental. Diphtheria has in several instances preceded the disease; while in other instances there is a history of slight injuries, exposure to cold, etc. When the individual has a predisposing hereditary taint, it is quite plausible to state that any lowering of the resisting power may precipitate the disease.

Pathology.—The pathologic changes consist in degenerative changes in the muscular fibers, marked increase in the muscular connective tissue, an increased amount of fat between the muscular bundles and connective-tissue fibers. Von Babes has found undeveloped and disintegrated muscle *nerve-plates*. Various cord-changes have been described, but no constant lesion is found, and the disease is at present regarded as a primary muscular affection—a tendency to excessive growth of the muscular connective tissues.

Symptomatology.—The first symptoms observed are motor weakness, difficulty in going up and down stairs, and a peculiar gait in walking.

The patients fall frequently and experience difficulty in rising, from muscular weakness of the back and lower limbs.

A pseudo-muscular hypertrophy commences simultaneously with the motor weakness and is due to a fatty infiltration of the affected muscles. The

calf muscles, infrascapulari, and deltoids first become affected, but eventually in from one to three years, all the voluntary muscles, with the exception of the

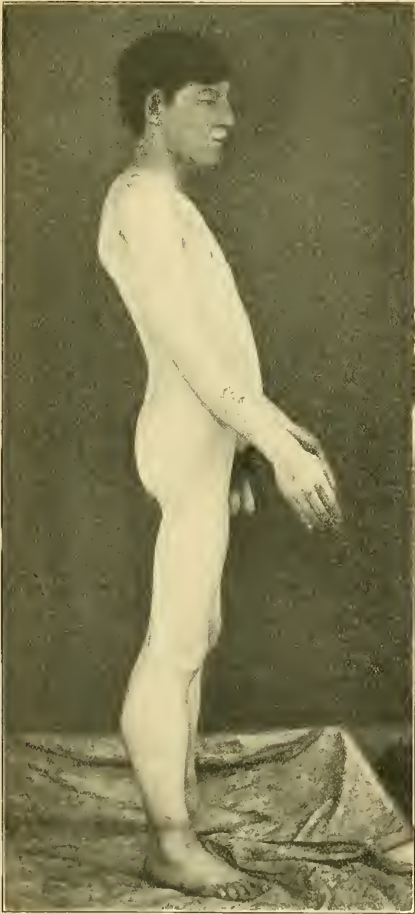


FIG. 499.—PSEUDO-MUSCULAR HYPERTROPHY, SHOWING ATTITUDE.

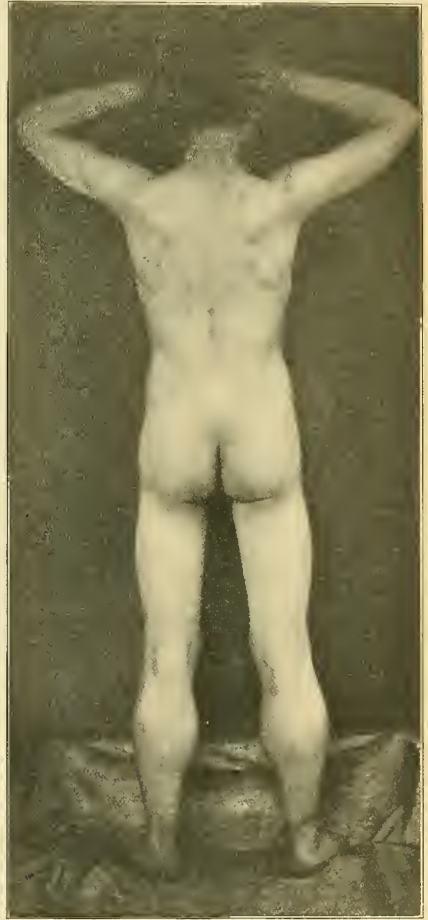


FIG. 500.—SAME, SHOWING ATROPHY OF BACK MUSCLES AND ENLARGEMENT OF LEGS.

pectorals, suffer. This is succeeded by atrophy, the wasting appearing first and being most marked in the pectorals and latissimus dorsi. The posture

and gait in walking are peculiar. Standing with the feet widely apart, the abdomen projects, the lumbar spine is arched forward in marked lordosis, the buttocks are thrown back and the shoulders forward.



FIG. 501.—PROGRESSIVE MUSCULAR ATROPHY.

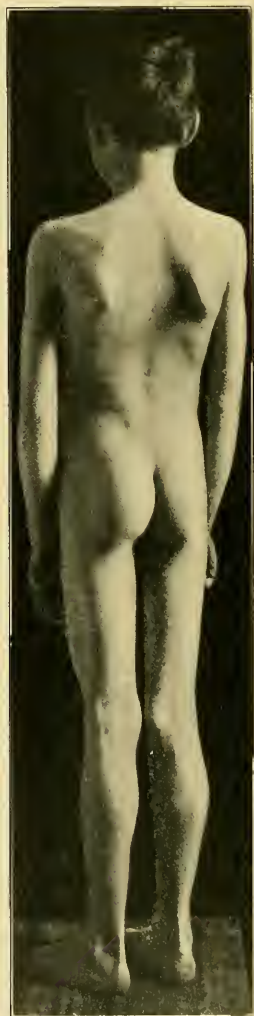


FIG. 502.—PSEUDO-HYPERTROPHIC MUSCULAR PARALYSIS.

In walking the center of gravity is brought well over each foot of the active limb to enable the passive leg to swing more easily forward, which gives a peculiar swaying waddle to the gait.

In advanced cases atrophy and contractions give rise to talipes equinus, flexion of knees and hip, and marked lordosis and scoliosis of the spine. The muscular contractility is lowered to both currents, knee-jerk disappears entirely in advanced cases, but sensation remains normal and rectal and vesical failure seldom occurs. Vasomotor disturbances are marked and a mottling of the limb is often seen. Mental weakness is often associated.

Diagnosis.—In well-marked cases the attitude, the peculiar walk, the

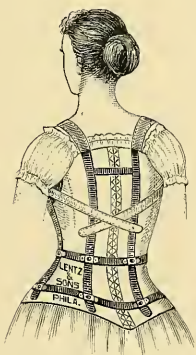


FIG. 503.—MORTON SPINAL SUPPORT, BACK VIEW.

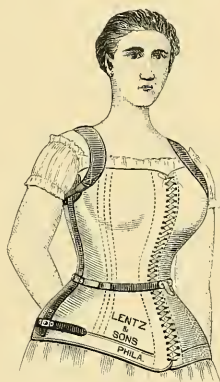


FIG. 504.—SAME, FRONT VIEW.

enlarged calf muscles, and particularly the association of these symptoms with enlargement of the infraspinati, with wasting of the latissimus dorsi and pectorals, are so characteristic as scarcely to be mistaken. The peculiar manner in which the patient rises from the floor and assumes the erect position is also characteristic of this disease.

The gait resembles that of spastic paraplegia, the paraplegia of rickets, and of Pott's disease; and these will be referred to in their proper places. Progressive muscular atrophy is the affection with which it is most closely allied, and from which it is most difficult, and in many instances impossible, to distinguish it. It is to be distinguished by the fact that it occurs later and the distribution of the atrophy is different. In pseudo-hypertrophy, the small muscles of the

trunk escape; in progressive muscular atrophy, the affection usually begins in these muscles.

Prognosis.—The prognosis in established cases is exceedingly grave. Under proper treatment the disease has been arrested, and cases of recovery have been recorded. Death occurs from exhaustion or some intercurrent affection—especially pulmonary disease. The disease after attaining its maximum may remain stationary for a long time, and eventually prove rapidly fatal. After the power of standing is lost, the patient will not probably live more than a few years.

Treatment.—Cases of arrest are reported following the use of electricity. In conjunction with systematic exercise, gymnastics, and massage, electricity offers the best means of arresting the disease. Tenotomy of the tendo Achillis is of great service where marked equinus exists, and in some cases tenotomy of the hamstrings may be performed. Mechanical apparatus is of little or no value, except the occasional use of a light spinal brace to relieve the lordosis. For this purpose the Morton brace (Figs. 503, 504) may be used.

Progressive Muscular Atrophy.

Progressive muscular atrophy is a chronic disease characterized by progressive atrophy of individual muscles or groups of voluntary muscles, independent of any antecedent motor or sensory paralysis, or of any metallic poisoning, and leading to deformity.

Synonyms.—*English*, Wasting Palsy; Paralysis Atrophica; Cruveilhier's Atrophy; Cruveilhier's Paralysis. *French*, Atrophie Musculaire Progressive. *German*, Progressive Muskelatrophie; Progressive Muskellähmung.

Etiology.—This is an affection of early and middle adult life, the earliest being two years, and the latest sixty-nine years of age. The average age of onset is said to be from twenty-five to fifty years. It affects more males than females, the proportion being about 6 to 1, possibly owing to muscular occupation and greater exposure of males.

Two forms have been distinguished by some writers: a spinal or myelopathic form, and a muscular or myopathic form, the former occurring after puberty from disease or violence affecting the spine, and the latter occurring congenitally, often hereditary, and sometimes influenced by consanguinity. In the spinal form various lesions are present—spinal progressive muscular atrophy, wasting palsy, chronic poliomyelitis, amyotrophic lateral sclerosis, Duchenne's disease, and Charcot's disease.

Three subdivisions of the myopathic form are recognized, first a fascio-scapulo-humeral form, myasthenia gravis, known as the Landouzy-Déjérine type, which primarily affects the face, shoulder, and arm muscles; second, the so-called juvenile form of Erb, which primarily affects the upper arm, shoulder and pelvic girdles, back and thigh; and third, the peroneal type, which begins primarily in the extensor muscles of the toes and finally involves all the muscles of the leg.

A hereditary form is also recognized by some writers, which does not differ in general aspects from the usual myelopathic form, but its occurrence in individuals with a neuropathic family history is common.

The most frequent exciting causes are excessive muscular action, exposure to cold and wet, traumatism to head, neck, or spine, anxiety and overwork, venereal excesses, constitutional syphilis, onanism, and antecedent febrile or zymotic affections. It is a not infrequent sequela of acute poliomyelitis in early life.

Pathology.—The lesions in the spinal form may occur in the entire motor tract of the nervous systems. There may be both peripheral and central lesions. In most cases the lesion does not extend beyond the medulla, but rare cases in which the cortex even has been involved have been reported. The degeneration in the lower neuron is at first usually peripheral, but in all marked cases atrophy and degeneration of the ganglion cells of the anterior horn are present. There is also sclerotic degeneration of the white matter of the direct and crossed pyramidal tracts; and the antero-lateral tracts are usually also diseased, especially in the cervical and upper dorsal portion of the cord. There is also a shrinking of myelin in the columns of Goll. The anterior cornual lesions are more marked above the dorsal portion of the cord, but the sclerosis of the crossed pyramidal tracts extends lower. If the disease mounts higher, it passes through the medulla, mainly in the gray matter below the fourth ventricle and the pyramidal tracts above the crossing, and may proceed through the internal capsules and peduncles to the cortical pyramidal cells, there undergoing a cellular degeneration, similar to that in the anterior horns of the cord. The pathologic changes consist in a simple atrophy of the muscular fibers, with a hyperplastic growth of the perimysium, either primary or secondary to a destructive cord lesion. Cord changes may be entirely wanting in the myopathic form. The fibers may undergo fatty degeneration and fat or the sheaths alone remain. There are often degenerated nerve-fibers in the nerve-trunks which can be traced to the anterior horns.

Symptomatology.—The invasion is always gradual and insidious. Some weakness or inability to use the affected member first attracts attention to the part, which is usually discovered to be wasted and shrunken. In adults the ball of the thumb or the shoulder is first affected; in children the lumbar muscles, and later the leg muscles are first attacked.

The disease may be arrested at any stage, or may invade other muscles,



FIG. 505.

FIG. 506.

FIG. 507.

FIGS. 505-507.—PROGRESSIVE MUSCULAR ATROPHY. BACK, FRONT, AND SIDE VIEW (Robert Jones).

till finally every voluntary muscle may be involved, except those of the eyelids, eyeballs, and the muscles of mastication, a condition approaching in severe cases absolute helplessness. The atrophy of the muscles of the hands gives rise to the peculiar "claw-hand" characteristic of the affection. The affected muscles are soft and flabby. The expression is vacant and idiotic, from palsy and atrophy of the facial muscles, producing the so-called myopathic face. The affected muscles during the progress of the disease present constant fibrillary



FIG. 508.



FIG. 509.



FIG. 510.



FIG. 511.

FIGS. 508-511.—PROGRESSIVE MUSCULAR ATROPHY, SHOWING HIGH DEGREE OF SCOLIOSIS (STEREO-SCOPIC) (Lange).



FIG. 512.



FIG. 513.



FIG. 514.



FIG. 515.

FIGS. 512-515.—PROGRESSIVE MUSCULAR ATROPHY, SHOWING HIGH DEGREE OF SCOLIOSIS (STEREO-SCOPIC) (Lange).

contractions visible under the skin, increased on exposure to cold. Electric contractility gradually diminishes with the waste of tissue. Sensation is unimpaired unless the posterior horns are affected, when pain of a neuralgic character is experienced. The mind remains unaffected to the end. Death is due to asphyxia from atrophy of the diaphragm, intercostals, and other respiratory muscles.

Progress is marked by repeated pauses extending over a few weeks to years, and the hereditary primary cases and those due to exposure to cold are more decidedly progressive to a fatal termination than those due to over-exercise of the muscles. The muscles of the bladder and rectum and the heart are never implicated. Permanent contractions result in talipes equinus and equinovarus, flexions, lordosis, and scoliosis.

Diagnosis.—The affection is most liable to be mistaken for peripheral palsy from disease or injury of a nerve, chronic lead-poisoning, and infantile paralysis.

In peripheral palsy the history of injury, the sharply localized distribution, the sudden onset of paralysis prior to atrophy, and the impairment of sensation, would distinguish the nerve lesion.

In chronic lead-poisoning the history, symptoms, distribution of the palsy, and mode of progress will generally make the diagnosis evident. The peripheral palsies from metallic poisoning will be most difficult of recognition.

In infantile paralysis the sudden onset of the paralysis preceding the atrophy, the loss of reflexes, and the "reaction of degeneration" are all of service in making a diagnosis.

Prognosis.—The prognosis is influenced by early treatment, but when the affection becomes generalized it grows, as a rule, progressively worse. The congenital primary cases are less favorable than those due to fatigue from over-exercise, since the former are liable to become rapidly generalized.

Treatment.—The general health requires attention, but local measures, especially electricity, offer the greatest hope. Strychnin ($\frac{1}{80}$ to $\frac{1}{40}$ of the nitrate) subcutaneously has been of great benefit in these cases. The continuous and interrupted currents are both of service; the more marked the atrophy, the more intense the currents and the more rapid the interruptions. Frictions and massage begun early and continued persistently for a long time may delay the progress of the affection, and diminish the severity of the resulting deformity. Vibratory massage is of some value. Tenotomy should be employed to relieve deformities produced by muscular contractions. When the atrophy is due to

excessive use, rest is important. This last statement cannot be too strongly emphasized.

Hereditary Ataxia.

Hereditary ataxia is a chronic degenerative disease of the posterior and lateral columns of the cord, characterized by serious motor disturbance, developed during childhood.

Synonyms.—*English*, Friedreich's Ataxia; Friedreich's Disease; Family Ataxia; Generic Ataxia; Degenerative Ataxia; Hereditary Ataxic Paraplegia.

Etiology.—The disease is inherited directly or indirectly, there being usually a family history of neuroses. Habitual intemperance, syphilis, consanguinity, and tuberculosis and other cachectic diseases have been ascribed as etiologic factors. Ataxia is rarely directly transmitted. The infectious fevers, especially scarlet fever, and diphtheria, dentition, and adolescence are usually the exciting causes. The disease, as in all other familial-neurotic diseases, is more usual in males, and it is mainly transmitted by the female line. In a family affected by this disease, the onset is usually progressively early in succeeding children. It develops in infancy and childhood, at puberty, and in early adult life. The affection is comparatively rare.

Pathology.—There are two forms, the cerebellar and spinal. The cerebellar is very rare, and shows cerebellar atrophy, said not to be sclerotic, however. There are unusual thinness of the gray substance, loss and degeneration of Purkinje's cells, and loss of white matter. The whole organ may be one-half or two-thirds smaller than usual. In these cases there seems to be no cord involvement. The spinal lesion is similar to that of locomotor ataxia—a primary degeneration of the lateral columns with degenerative atrophy and sclerosis of the posterior columns. It commences in the lumbar region, and extends upward and downward, involving finally the medulla, and particularly the origin of the hypoglossal nerve. According to Marie, the upper motor neurons are not directly affected, the fibers affected in the pyramidal tracts being those relating to the direct cerebellar tracts and Gowers' tract, being those portions of the cord last developed. The cord is usually small, presenting only two-thirds of its normal size. The difference is clinical and etiologic rather than pathologic.

Symptomatology.—The earliest symptoms are weakness and uncertainty in walking, with slight numbness and pain in the lower extremities. The motions of the legs are improperly co-ordinated. Irregular jerking of the

head and neck are seen. Headache, vertigo, and impairment of speech, and nystagmus are often present.

The patellar reflex is early lost; trophic disturbances are slight; the sphincters are, as a rule, unaffected; cutaneous anesthesia is usually absent. Incoordinate or choreiform movements may develop in the extremities.

Deformities occur in the later stages—talipes varus or equinovarus, hyper-

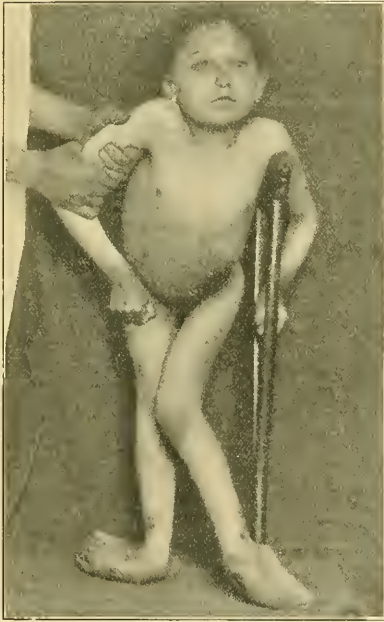


FIG. 516.—SPINA BIFIDA IN A GIRL OF TWELVE YEARS (Lange).



FIG. 517.—SAME, LATERAL VIEW.

extension of the toes, permanent flexion of the knees, and lateral curvature of the spine.

Diagnosis.—The distinguishing characteristics are the development early in life of ataxia, paraplegic in character, with loss of reflexes, disturbances of speech, and deformities, without cutaneous anesthesia, acute pain, or paralysis of sphincters, but with hereditary or family history of neuroses. The absence of the Argyll-Robertson pupil distinguishes hereditary ataxia from locomotor ataxia.

Prognosis.—The disease is progressively fatal, death usually occurring from some intercurrent affection, the average duration of the disease being fifteen or twenty years.

Treatment.—Improved hygiene with persistent regular massage is of the greatest service. Suspension, as in locomotor ataxia, should be tried, and cases are recorded in which it proved beneficial. The infectious diseases of childhood, especially scarlet fever and diphtheria, should be especially avoided, and injury by blows or falls should be guarded against.

Electricity may be employed to maintain the nutrition. Tonics, especially arsenic, are sometimes of temporary benefit. The animal extracts may be tried. Flat-foot, club-foot, and lateral curvature require the appropriate treatment described in the other sections.

Peripheral Palsies.

1. **Spina Bifida Paralysis.**—The deformity and paralysis associated with spina bifida are sufficiently common to deserve consideration here. The paralysis is most common in the sessile variety, and is accompanied by an impairment of motor power in the entire lower extremities with contraction of the extensor longus digitorum and hamstring tendons. The patient walks with knees flexed and the feet in a position of valgus.

The treatment consists in dividing the tendons of the contracted muscles and the use of paralytic leg braces with pads at the inner side of the knee and ankle.

2. **Pressure Palsies.**—These result from pressure upon nerve-trunks by causes operating both within and without the body, such as by tumors, aneurysms, foreign bodies, excessive bone callus, the use of crutches, or as the result of certain avocations or professions.

The symptoms resemble those of infantile spinal palsy. The prognosis is good if the cause can be removed. The treatment consists in removal of the cause in so far as possible, followed by electricity, massage, and vibration. Neuroplasty has been successfully employed in cases where the nerve has been completely included in callus.

CHAPTER XXI.

TORTICOLLIS.

Torticollis is a distortion of the neck, constant or intermittent in character, in which the head is drawn awry.

Synonyms.—*English*, Wry-neck; Caput Obstipum; Collum Distortum. *French*, Cou Tortu; Coutors. *German*, Schiefhals. *Italian*, Torticollis. *Spanish*, Torticollis.

Frequency.—According to some writers, the sexes are about equally affected; but according to others, males are more frequently affected than females; and according to others, females are more frequently affected than males. Thus, in 444 cases collected by Whitman, 246 were females and 198 were males. The right side was formerly thought to be more liable than the left, as seen by the 37 cases collected by Dieffenbach, in which 5 only were on the left side, and in 29 cases recorded by Bouvier, 18 were on the right side. But, on the other hand, Whitman's figures seem to show a greater frequency of torticollis on the left side, for of the 444 cases recorded by him in 432 of which the affected side was mentioned, 196 were on the right and 236 were upon the left side.

Etiology.—Wry-neck is both congenital and acquired, the latter being much more common than the former.

Congenital.—Cases are recorded of wry-neck in a stillborn infant, and a case of unilateral atrophy of the head, but the majority of so-called congenital cases occur at birth from injury. In the true congenital variety the wry-neck is caused by a malposition of the fetal head in the maternal pelvis, producing permanent shortening of the relaxed muscles. This may be favored by deficiency of liquor amnii, by abnormal pressure of the uterus, or possibly, as Petersen suggests, may result from an attachment between the skin of the face and the amnion in early embryologic life.

A lateral deficiency of the cervical vertebrae may also, though more rarely, cause it. The fact that congenital torticollis affects, as a rule, the *right* side is easily explained by the great predominance of the left occipital anterior position of the fetus, since in this position the fetal head lies in the pelvis in a

position of flexion toward the right shoulder, and this position, if extreme or long continued, will produce a shortening of the right sternomastoid, the muscle most frequently affected. In such cases the deformity may not be altogether muscular, but may extend to and involve the skull and cervical spine. In congenital cases heredity appears to play a rôle, as shown by numerous recorded cases. The frequent association with other deformity in congenital cases points to malposition *in utero* as a cause. I am convinced that numerous cases

of congenital wry-neck may be traced to prenatal nervous lesions, either central or peripheral.

Acquired.—The acquired form includes several varieties, which may be grouped into rheumatic, traumatic, tetanoid, paralytic, compensatory, cicatricial, and idiopathic.

Rheumatic torticollis is a very common affection seen in persons who have inherited the rheumatic diathesis or who have acquired lithemia.

Traumatic cases result from blows, twists of the neck, rupture of the sternomastoid muscle, and from violence received during forceps delivery, pressure, or the manipulations of the accoucheur. Rupture of the muscular fibers, particularly of the sternomastoid, is produced with sub-



FIG. 518.—DEFORMED SKULL FROM TORTICOLLIS
(Joachimthal).

sequent induration and cicatricial contraction of the muscle. This rupture may occur in a muscle shortened *in utero*. Hematoma of the muscles is often present, but its relation to wry-neck is at present undetermined. According to Stromeier's theory, congenital torticollis is caused by rupture of the muscle producing a myositis and hematoma which goes on to fibrous induration and consequent contraction of the muscle. But this theory is now discarded, since the association between hematomas and torticollis is by no means constant. Petersen believes hematoma is found in already existing torticollis, Fassbender has observed it upon the side opposite to the wry-neck, and the experiments of Witzel and Fabry upon rabbits

failed to prove that hematomas produce torticollis. Petersen vigorously combats the theory of Stromeyer, Weiss flatly denies it, but personally I believe that the majority of causes of congenital torticollis operate before rather than during delivery. In rare cases fracture and dislocation of the cervical vertebrae have been observed as causes.

Tetanoid or *spastic* contraction of the muscles of the neck, either tonic or clonic, results from a central lesion; from a peripheral irritation, as from inflammatory conditions of the bones, ligaments, or muscles; or as a local manifestation of some central or spinal irritation. Choreiform spasm sometimes occurs. Peripheral irritation is a common cause of acquired torticollis.



FIG. 519.—RIGHT DORSAL SCLIOSIS IN MUSCULAR SUBJECT, SECONDARY TO TORTICOLLIS.



FIG. 520.



FIG. 521.

FIGS. 520, 521.—OCULAR TORTICOLLIS FROM HYPERMETROPIC ASTIGMATISM (Joachimsthal).

Paralytic wry-neck may arise from unilateral muscular action in paralysis of the other side, either peripheral or central in origin.

Compensatory torticollis is met in lateral curvature, but in many instances of association of these two conditions, the wry-neck will be found to be primary. Of a compensatory nature also are those cases of wry-neck developed from unilateral loss of vision, inequality of visual acuity, or a difference in the plane of vision of the two eyes—amaurosis, astigmatism, or hyperphoria. This condition has been termed by Quignet, *torticollis oculaire*—a not infrequent condition in the writer's experience.

Cicatricial wry-neck results from extensive burns and scalds, abscesses, cicatrices from suppurating cervical glands, or lupus of the neck.

Idiopathic cases occur in which no definite lesion is discoverable, but in which general nervous debility has developed a local spasm as a result of some emotional cause, such as grief, fright, etc.; or as an accompaniment of hysteria. Among other causes may be mentioned tumors of the sternocleidomastoid muscle—sarcomatous, fibrous, or syphilitic. The long-continued holding of the head in a strained position may produce a torticollis, as seen in certain occupations, or the condition may result from carrying heavy burdens on one shoulder.

Pathology.—In the traumatic cases occurring at birth, the pathology consists of a laceration of the sternomastoid muscle from torsion of the neck, followed by hemorrhage, succeeded later by an encapsulating inflammation and a fibrous induration and shortening of the muscle, in severe cases the entire muscle being converted into a fibrous band. In the chronic forms alterations occur in the muscles, fascias, ligaments, and bones from malposition or disuse. The muscles most frequently involved are the sternocleidomastoid, trapezius, splenius, scaleni, rarely the complexus, and the platysma, although in severe cases all the muscles of the neck participate. This affection involves the distribution of the spinal accessory nerve, and is usually due to central disease, lesion of this nerve, or disease of the muscles themselves. The affected muscles undergo fibrous degeneration, becoming hard and unyielding. The contraction continuing, anatomic changes are produced which not only tend to fix the cervical vertebrae in their deformed relations but also to exaggerate the abnormal curves and produce other compensatory curves. These changes are chiefly atrophy of the bones and intervertebral cartilages on the concave side of the curve, with shortening of the ligaments and muscles, and hypertrophy of the bone and cartilage, with elongation of the ligaments and thickening of the muscles on the other side. Asymmetry of the face has been ascribed to gravitation of the blood to the more dependent side; to muscular tension; to pressure and retarded development of the vessels and nerves on the side of the concavity;

to tension of the soft parts, particularly the muscles of the sound side; and to interference with function. Atrophy of the affected side and asymmetry of the skull have been variously ascribed by different authors to deficient activity of the muscles of inspiration on the affected side, as in ordinary scoliosis; to the constant pull of the contracted sternomastoid muscles; to faulty nutrition on account of compression of the carotid artery and other great vessels of the neck on the affected side (Bouvier); to interference with the function of the part, causing atrophy from disuse, as in asymmetry of the face; to hyperextension of the muscles on the sound side; and to the misplacement of the epiphysis of the basilar portion of the occipital bone, and the effect of the weight of the skull upon the other cranial and facial bones (Nicoladoni). Of these the theory of Bouvier perhaps best explains the atrophy, and that of Nicoladoni the asymmetry of the skull and also the osseous changes in the face. The sternal head of the sternocleidomastoid is more frequently affected than the clavicular head, the clavicular head being rarely involved, but when involved it is always associated with an involvement of the sternal head.

Symptomatology.—The affection may be acute or chronic, constant or intermittent. In the acute form the onset is usually sudden, often succeeding a sudden violent movement or effort. There is pain on motion, with tenderness of the affected muscles, and the head is held awry. The affected muscle is tense and stands out prominently from beneath the skin. Its response to electric stimulus is diminished. The acute form may become chronic. The position of the head varies with the muscles affected. In the most common variety, in which the sternocleidomastoid muscle is affected, the head is drawn to one side, the face being rotated in an opposite and somewhat upward direction and in severe cases the face may look directly to the sound shoulder and the neck on the affected side be buried out of sight. The malposition of the head cannot be forcibly corrected, and attempts to do so cause pain. Asymmetry of the face, the oblique position of the nose, the irregularity of the eyes and commissures of the lips, the diminished size of the features on the affected side, are peculiar and characteristic. Asymmetry of the face is rarely lacking, whether the wry-neck be congenital or acquired. Marked atrophy of the affected side and asymmetry of the skull are present in severe grades of the affection. In severe cases the jaw is frequently rotated so that the teeth cannot be approximated. In chronic cases a compensatory lateral curvature of the spine results from the curvature. Intermittent torticollis, either unilateral or bilateral, is essentially a nervous affection occurring in later life, and is often choreiform.

Convulsive contractions vary from an occasional jerk to an almost constant spasm. It is more frequent in females, is usually clonic, but may become tonic, and is often painful. When unilateral it constitutes the so-called *tic giratoire* of Trousseau. Another variety, described as occipito-atloidean, consists of a subluxation of the atlas on the occipital bone, producing a twisting of the head which resembles torticollis, and which is a bony ankylosis, a rheumatic sequel.

Diagnosis.—While there is little difficulty in recognizing the deformity itself, it is most important to distinguish it from other conditions, such as cervical caries, simple cervical abscess and cervical adenitis, in which the head is held awry without muscular spasm or contraction. The diagnosis as to which muscles are affected is made by palpation, when the contracted or retracted muscle may readily be felt as a tense prominent band under the skin. Ordinary stiff-neck from cold may at all times be easily distinguished by the *history* of exposure to cold, by the transitory, shifting, and less severe character of the affection, the pain and tenderness on pressure. Cervical caries can usually be distinguished by the greater rigidity, by more severe pain and its persistence even when the patient is recumbent, by dysphagia, the attitude of the patient, supporting the head with the hands, the facial expression of pain, and the coexistence of tubercular diathesis or lesions elsewhere. In anterior torticollis due to caries, the sternomastoid is not so permanently nor so prominently contracted. In posterior torticollis due to caries the symptoms are almost identical with those of posterior idiopathic torticollis, but the fact that in spinal caries the head is rotated *toward* the contracted muscle, whereas in idiopathic cases of wry-neck the rotation takes place *away* from it, is of the greatest diagnostic value. Again, in spinal caries all movements of the neck are resisted and attended with pain, whereas in wry-neck the movements are freer and only certain muscles are firmly contracted, the rest being relaxed. The greatest importance attaches to the differential diagnosis between posterior idiopathic torticollis and torticollis due to cervical caries, since the writer has had related to him a case where an attempt forcibly to straighten a case of torticollis due to cervical caries resulted in instant death. In simple cervical abscess the symptoms are those of acute local inflammation, superficial in character and attended with fever, and in cervical adenitis there is circumscribed, deep-seated inflammation, without characteristic muscular spasm. The paralytic form may be recognized by the unsupported head falling away from instead of toward the affected side, by the ability to correct the deformity but the

immediate return of the head to its deformed position as soon as the corrective force is removed, and by evidences of paralysis elsewhere. However, it must be remembered that if the paralytic torticollis be of long standing, the muscles on the unaffected (nonparalyzed) side may become atrophied and permanently retracted instead of simply relaxed, and the head would then be held in a position away from the paralyzed side, and any attempt to correct the malposition would be resisted and rendered impossible by the contracted muscle.



FIG. 522.—RIGHT DORSAL SCLIOSIS. INEQUALITY IN SCAPULÆ AND HIPS, SHOWING TORTICOLLIS.

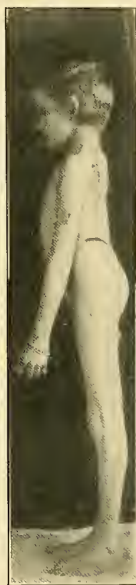


FIG. 523.—SAME, SIDE VIEW.

Prognosis.—Acute idiopathic muscular torticollis tends rapidly toward recovery, but may become chronic. Wry-neck due to peripheral irritation terminates usually upon removal of the cause. Paralytic cases require time and the recourse to mechanical appliances. Traumatic cases, the so-called congenital cases, and the ordinary chronic acquired affection are entirely curable by surgical means. The deaths reported following operation for torticollis have been due to hemorrhage, septicemia, and injury to the pleura. The intermittent form may cease spontaneously, but usually remains unchanged for years, unless

subjected to surgical interference, when encouraging success usually follows radical operation.

Treatment.—The treatment will depend upon the variety, and may be divided into therapeutic, mechanical, and operative.

Therapeutic. In acute inflammatory forms much benefit will be obtained by the correction of the coincident constitutional disturbance. A gentle purge, followed by salicylate of soda, with the local application of warmth, the oleate of morphin, or atropin, injected directly into the belly of the contracted muscle, will be all that is required. Much comfort may be obtained in very painful cases by supporting the head by means of a high pasteboard collar bandaged firmly around the neck, in addition to the hot applications,

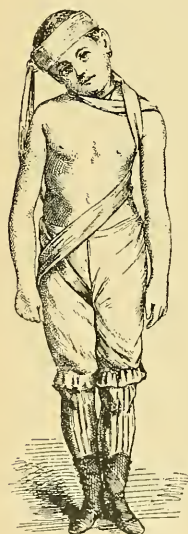


FIG. 524.—LORENZ BANDAGE FOR TORTICOLLIS (Hoffa).



FIG. 525.—PLASTER CRAVAT FOR TORTICOLLIS (Joachimsthal).

etc. In paralytic cases the endermic use of strychnin is recommended. Verneuil recommends pulverizations of ether as being most efficient. When dependent upon general debility, the health should be restored by means of tonics, massage, improved hygiene, and general bathing. When dependent upon ocular defect, the insufficiency should be corrected with prisms, tenotomy being performed only when the insufficiency amounts to twelve degrees or over. In a case of the writer's a one degree prism, base down, in the left eye corrected the insufficiency, and, with the proper correction for hypermetropia, relieved the torticollis. Electricity

is of value and is often followed by cure. Gelsemium (fluid extract) in physiologic or hyper-physiologic doses, as suggested by Weir Mitchell, may be employed after failure to relieve the muscular spasm by galvanism or before resorting to nerve resection. In intermittent cases the actual cautery to the back of the neck is recommended. In chronic cases of posterior torticollis forcible straightening under an anesthetic without tenotomy has been successfully employed by Delore. In these obstinate cases tenotomy of the deeper posterior muscles is impossible. The method of Delore consists in anesthetizing the patient, and while an assistant firmly holds the shoulders, the surgeon grasps the head firmly with both hands and gradually but forcibly rotates it in all directions. When the deformity is overcome, the head, neck, shoulders, and trunk are fixed in an over-corrected position by a plaster-of-Paris bandage. A positive diagnosis of posterior torticollis from caries of the cervical vertebrae must be made before resorting to this plan of treatment.

Mechanical. Mechanical appliances without operation are unsatisfactory, except in paralytic cases. In these, after the therapeutic means have failed to recall the lost muscular power, mechanical apparatus is useful. The mechanical principle involved is to obtain fixation on the trunk, from which counter-pressure is made upon the head. After its application the apparatus should be worn from three to five months, when it may be permanently discarded.

The mechanical appliances used to retain the head in its correct position after operation are both numerous and varied. A simple and most efficient form of appliance consists of a broad adhesive strip around the forehead and occiput, and another around the waist, fastening the two together by means of a bandage or rubber band carried from above the ear of the unaffected side across the chest to the opposite side of the trunk.

After operation the head may be secured in a slightly over-corrected position by incasing the head, neck, and shoulders in a plaster-of-Paris cast.

More elaborate appliances are needed to twist the head, and these are all constructed upon the principle of that of Jörg. Of these a great variety exist, and are well illustrated in the chin-rest used in the treatment of cervical cases and in the accompanying illustrations of that of Sayre, recommended

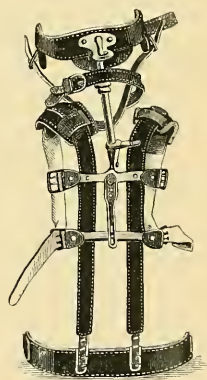


FIG. 526.—SAYRE'S BRACE FOR TORTICOLLIS.

by the writer. The apparatus of Sayre consists of two upright malleable steel bars which pass up the back on either side of the spine and curve over the shoulders, on which they rest. Below, they are attached to a band passing around the pelvis. The head-piece is supported upon a rod by a universal joint attached by means of a similar universal joint to the spinal uprights at a point corresponding to the first dorsal vertebra, or, what is preferred, by three Archimedean screws, since the former requires two persons for a proper adjustment. This rod has a ratchet and key movement for elongation. The head-piece, a padded piece of malleable steel, runs from the base of the skull



FIG. 527.—TORTICOLLIS BEFORE TENOTOMY OF THE STERNOMASTOID MUSCLE (Joachimsthal).



FIG. 528.—SAME, AFTER OPERATION.

forward and upward, curving over each ear. From the ends of the metal head-piece a leather strap, made adjustable by a buckle, passes across the forehead, and, by means of hooks, a strap is attached which passes under the chin.

Collars of pasteboard, felt, leather, and wire, sometimes spoken of as Minerva collars (*collier Minerve*), from the simplest to the most elaborate forms, are employed to fix the distorted head, but these are most efficient after operation.

Operative treatment. The operative procedures employed are tenotomy, nerve-stretching, nerve-division, and nerve-resection.

Tenotomy of the sternomastoid is most frequently required, and this may be performed subcutaneously or by open incision. For the technic the reader is referred to Part I.

The post-operative treatment consists in securing the head in an over-corrected position, by plaster dressing or other mechanical means, for from ten to fourteen days, when the after-treatment should be begun. This orthopedic treatment, which is the most important and upon which the success of operation depends, consists in massage of all the muscles of the neck and the gradual but forcible manipulation of the head in such a manner as to stretch the formerly shortened muscles and to strengthen the weaker muscles.

If the patient is afflicted with posterior torticollis with inclination of the head toward the left shoulder and the chin rotated to the right, certain special exercises are necessary, and these should be given by the surgeon himself or should be entrusted to a skilled

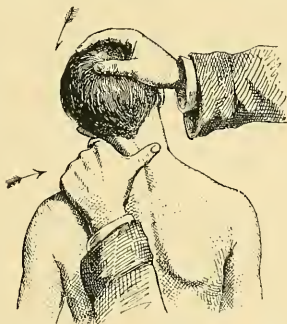


FIG. 529.—MANUAL CORRECTION FOR TORTICOLLIS (Hoffa).



FIG. 530.—SUSPENSION CORRECTION FOR TORTICOLLIS (Hoffa).

gymnast. The following exercise has been found of great value: the patient is seated upon the plinth with the feet fixed in the stirrups and the thighs secured with a strap. The surgeon or gymnast stands behind the patient and seizes the left lower jaw of the patient with his left hand, and with the other hand on the right side of the patient's head, rotates the head toward the right. In this

manner the movements of the head are under the perfect control of the surgeon and the correct position is secured and maintained for a time. One treatment may be followed by a cure.

In small children the patient may be placed between the knees of the surgeon and the head may be gently but firmly corrected from behind.

A very useful exercise is one which can be given in the Weigel-Hoffa lateral curvature machine. The head extension is so arranged that the straps are shorter on the side of the deformity. When the head is extended, the deformity is corrected.

A home exercise may be given consisting of the patient swinging in an extension head-gear, the cord of which is not attached to the center of the bar but on the bar toward the side of the contracted muscles. A weight should be held in the hand of the affected side.

Nerve Operations. In intermittent torticollis resection of the spinal accessory nerve has been successfully employed. The technic has already been given in Part I, to which the reader is again referred.

In obstinate cases resection of the posterior roots of the upper cervical nerves has been successfully performed. This is a very difficult operation, and one which will test the dexterity of the most skilful surgeon. The nerve-supply of the posterior rotators, the rectus capitis, splenius capitis, posticus major, and obliquus inferior, must be paralyzed.

The operation as described by Keen* is a very efficient one. At the level of a point one-half inch below the lobule of the ear a transverse incision is made beginning posteriorly at the mid-line of the neck and running forward for two and a half inches. The trapezius and complexus are divided transversely, carefully avoiding the great occipital nerve. The posterior branch of the second occipital nerve is resected. The suboccipital nerve is exposed in the suboccipital triangle. It is followed down and divided close to the spine. Just below the great occipital nerve the common trunk of the two roots is exposed and divided close to the bifurcation of the nerve-trunk. The nerve-supply of the affected muscles is thus removed, causing a paralysis and consequent relaxation of these muscles.

Richardson and Walton produced very satisfactory results by simply resecting the nerves which supplied the affected muscle, combining this with myotomy if the contraction was permanent.

* "Annals of Surgery," January, 1891.

CHAPTER XXII.

NEUROMIMESIS.

Neuromimesis includes certain functional or mimicked affections associated with the hysteric diathesis.

Synonyms.—These affections have been variously recognized as simple hysteria; as *Gelenkneuröse*; as the mimicry of disease; and as hysteric joint affections. *Italian*, Isteria mimetica, Neuromimesi. *Spanish*, Neuromímesis.

Frequency.

The frequency with which joint diseases are mimicked is very great. The assertion may be made and fully indorsed by the experience of competent observers that four-fifths of the female patients in the upper classes of society who are supposed to have joint disease have hysteria and nothing else. It is frequently encountered among the lower classes also.

There is no type or form of organic paralysis, no contracture or spasm, and no articular deformity depending upon chronic inflammation or disturbed muscular action, which may not be simulated in hysteria. The knee, hip, spine, and ankle are most frequently affected in the order named.

Etiology.

These affections are most common in women of a pronounced brunet type, and usually appear about the time of puberty or young womanhood. The manifestations may continue until the menopause or even later, and are often associated with ovarian or uterine disorders. Men and boys are not exempt. Debility, ill health, and neurasthenia are often associated. Heredity and education are the most important predisposing causes. Errors of refraction are sometimes the starting-point of a hysteric explosion. Traumatism is often an exciting cause. Real disease is often present, but the symptoms are all exaggerated, and hysteria is imposed upon an original organic pathologic condition. The etiology, in fact, differs but little from the etiology of hysteria in general. The local manifestation is engrafted upon a state in which ideas control the body and produce morbid changes in its functions.

Symptoms.

These include three groups—the paralyses, spastic contractions, and joint disease.

Paralyses.—These vary from slight transitory loss of power, which can hardly be termed palsy, to severe cases of long standing, which may be readily mistaken for lateral sclerosis, as in the case which Osler, in 1879, frequently showed at the Montreal General Hospital as a typical example of lateral sclerosis, and which after persisting for eighteen months disappeared completely. In form they may be hemiplegic, paraplegic, or monoplegic, the paraplegic being most frequent. Left-sided hemiplegia is more common than right, in the proportion of about 4 to 1. Very frequently the local palsy is associated with a contraction of the opposing set of muscles. Anesthesia limited in area to the part affected is to be noted, together with a bluish discoloration of the skin over the affected part. The reflexes may be increased, but the electric reactions are normal and atrophy is absent. Hyperesthesia, aphonia, and paralysis of the bladder are usually associated.

Spastic Contractions.—These may occur gradually, following paralysis, but usually they develop suddenly and disappear rapidly, at the termination of a variable period. Almost any group of voluntary muscles may be attacked, and the distribution may be hemiplegic, diplegic, paraplegic, or monoplegic. The contracted part is rigid like an iron bar. Both flexors and extensors are in action, but the extensors usually predominate.

In hemiplegic cases there is often associated complete analgesia, deficiency of hearing, smell, taste, and retraction of the visual field on the affected side. Next to contraction of the arm, paraplegia is most common. In cases of long standing a certain degree of muscular atrophy may be present, but without the reaction of degeneration. True hysteric aura, beginning in the contracted part, terminating in globus hystericus, and followed by aphonia, are sometimes observed. Of this nature also is hysteric club-foot, described in another section.

Joint Disease.—Disease of any articulation may be mimicked, but it usually affects the knee or hip, spine, or lower jaw. The joint is usually hyper-sensitive, rigidly fixed or preternaturally mobile, and swollen. Atrophy occurs from disease only, but the electric reactions are unchanged. Motion is painful, and the patient walks with a limp. The sleep is unaffected and “night pains” are absent. Superficial hyperemia may increase the surface temperature. An occasional very high temperature of 108° or 110° should excite suspicion.

Organic disease may succeed the neuromimetic disturbance, as in the ankle-

joint case of Esmarch, about which for many weeks he was undecided, which ultimately proved to be caries sicca, requiring amputation, and in the remarkable knee-joint case recorded in Weir Mitchell's lectures. In the latter the hysteric element was pronounced, but on account of its chronicity so eminent an authority as Billroth pronounced it organic, and Sands, upon operating, found the joint surfaces normal and non-tuberculous inflammatory thickening outside the joint.

True permanent contractures from sclerosis may follow the hysteric condition in rare instances, as in a recent case of a boy of six years under the care of the writer. At first the subject of extreme general bizarre contortion of all the flexor muscles, it eventually affected all the extensors and was permanent under full anesthesia.

Diagnosis.

The presence of hysteria in any of its protean forms should put the practitioner on his guard in regard to the nature of any motor or joint affection.

The neuromimetic paralyses may be gradual or sudden in onset, but are usually associated with anesthesia, paralysis of the bladder, aphonia, or other hysteric manifestation.

The neuromimetic contractions are very deceptive, but they disappear under full anesthesia. The extension and rigidity of the part, the occurrence of areas of anesthesia, the occurrence of the so-called "blue edema" of the French, deficiency of the special senses, particularly retraction of the visual field, and the hysteric aura, are of diagnostic value.

The neuromimetic joint affections have symptoms in common with both chronic synovitis and chronic osteitis of the joints. The absence of true reflex spasm, the normal electric reaction of the muscles to the faradic current, the absence of a rise of temperature,—either local or constitutional,—and the association of globus hystericus, and of emotional attacks of weeping and crying, will serve to distinguish the hysteric affection from the true organic disease. The rigidity, moreover, yields to mild force if the attention is diverted, and wholly disappears under the usual doses of chloral or opium, and complete anesthesia.

In doubtful cases x-ray photography will be found of value in deciding the question of a true pathologic lesion of the joints.

Treatment.

The successful treatment of these affections requires a knowledge of human nature, and great tact, together with consummate skill. The general condition,

and particularly the general *morale* of the patient, require attention. Tonics, nerve sedatives (with positive interdiction of morphin), electricity, and massage are of great service. Preparations of valerian, zinc, and iron are to be recommended. On account of the frequent complication of neurasthenia, the method of Weir Mitchell offers the best advantages and is particularly applicable to these cases. It consists of free nourishment, isolation, rest, massage, and electricity. The assistance of an intelligent nurse is essential. In regard to the local affection—the neuromimesis—the treatment consists in diverting the attention from the affected part. In conducting this part of the treatment a positive diagnosis is necessary. This being assured, the attention may be diverted abruptly or gradually. The first plan, which is scarcely legitimate in regular medical practice, consists in suddenly commanding the patient to use the affected part, after the method of charlatans and faith-healers. Hypnotism has of late been extensively employed for the same purpose, but is useful only in selected cases, and is not of much value in neuromimetic affections.

The second and usual method consists in the gradual diversion of the mind from the affected part, and the gradual use of the part. The application of mechanical force is positively contraindicated and the use of apparatus is entirely secondary. In spastic contractions and joint affections light traction in the line of deformity may be applied for a time. The use of the limb is then encouraged, pain being disregarded. Massage and electricity hasten the cure, the massage being used daily as a substitute for exercise.

Operative treatment is usually contraindicated, but if the contracture persist for a long period, despite thorough treatment, tenotomy may be resorted to, sufficient instances having been recorded to establish this method of procedure.

CHAPTER XXIII.

NEUROPATHIC AFFECTIONS OF JOINTS.

Charcot's Disease.

Destructive forms of arthritis occur chiefly during the course of locomotor ataxia and syringomyelia, but are also found associated with other diseases of the central nervous system,—especially lesions of the anterior cornu,—as cerebral hemorrhage, injuries to the spinal cord and peripheral nerves, tumors of the spinal cord, acute myelitis, anterior poliomyelitis, progressive muscular atrophy, Pott's disease, and stab wounds of the spinal cord.

Synonyms.—Spinal Arthropathy; Arthropathy; Tabetic Arthropathy; Neural Arthropathy.

While particular attention has been attracted to this subject by the writings of Charcot, Allbutt, Raymond, Hitzig, Gull, and others, it is interesting to observe that to a distinguished American physician of Philadelphia, Dr. John K. Mitchell, belongs the long-forgotten credit of the first discovery that an "obvious spinal cause may produce a rheumatism characterized by heat, pain, redness, and tumefaction, and the direct connection between Pott's disease and acute inflammations of the joints, and between traumatism and acute joint diseases."

Etiology.—The most common spinal arthropathy is that dependent upon degeneration of the posterior columns, or locomotor ataxia—the one particularly referred to by Charcot. Hemiplegic arthropathies have been studied. Two varieties have been recognized—an acute or subacute form and a chronic form. The disease is usually met in adults, but cases are recorded as early in life as the sixth year. The right and left sides of the body are affected about equally, and all the major joints are affected and many of the smaller ones. Usually but one joint is affected, but occasionally two or more are diseased. Of all the large joints, the knee-joint is most frequently affected. Thus in the 169 cases analyzed by Weitzächer, the knee was affected in 78, the hip in 31, the shoulder in 21, etc. These occurred in 109 individuals, of whom 72 were men, and 37 women.

The frequency of arthropathy in tables is estimated to be about 5 to 8 per

cent. Very frequently more than one joint is involved. Flatow gives the distribution as follows:

Knee, ...	60; bilateral in 13 instances.
Foot, ...	30; " " 9 "
Hip, ...	38; " " 9 "
Shoulder, ...	27; " " 6 "

In a report of 217 cases Chepault gives the distribution as follows:

Knee, ...	120 cases.
Hip, ...	57 "
Foot, ...	40 "

There have been 15 cases of Charcot's disease of the vertebral column reported.

Bradford and Lovett, in a report of 107 cases of Charcot's disease, give the distribution as follows:

Knee, ...	78 cases.
Hip, ...	13 "
Shoulder, ...	21 "
Tarsus, ...	13 "
Elbow, ...	10 "
Ankle, ...	9 "
Wrist, ...	2 "
Jaw, ...	2 "
Spine, ...	1 case.

The exact mechanism of the production of these arthropathies has been a matter of much discussion. The discovery of arthropathies caused by injury of nerve-trunks promised to simplify the research, but while it has been shown that they are caused neither by vascular palsy, vasal spasm, nor by inertia, as suggested by Mitchell, the local nerve irritation probably influences the center, and through it and the entire nerve thread acts upon the joint to disturb its nutrition.

The theory that these arthropathies are only the result of constant traumatism upon joints whose sensitiveness was destroyed, as in conjunctival troubles following section of the facial nerve, is no longer tenable. Virchow's assertion that the distinction is due to faulty cellular or trophic change in the joint explains nothing. In some cases without peripheral irritation the disturbed centers are capable of producing joint lesions. The tabetic arthropathies occur independently or precede the active symptoms of spinal lesion. In hemiplegic cases

the arthropathy occurs from fifteen days to three months after the apoplectic attack, coincidently with the advent of "late rigidity," a symptom commonly ascribed to descending sclerosis. Occasionally the arthropathy may be observed as early as the day after an attack of hemiplegia, or on the third day.

Pathology.—The pathologic changes which occur in Charcot's joint disease, like those of syringomyelia, resemble somewhat those seen in arthritis deformans. There is marked effusion, which is rarely clear but is generally brownish from disintegrated blood or may be cloudy from flocculi. Fibrous degeneration of the articular cartilage takes place, and on account of the con-



FIG. 531.—ATAXIC ELBOW-JOINT.



FIG. 532.—ATAXIC HIP-JOINT.

tinual pressure, is gradually destroyed along with the underlying bone, and replaced by fibrous tissue infiltrated with calcareous salts. On account of static causes this degeneration and destruction of the cartilage and bone take place unevenly. There are usually no areas of denuded bone, although section of the bone shows it to be soft and eburnated. As the destructive process continues there occur irregular formations of osteophytes, especially around the periphery of the articulating surfaces, and hypertrophy of the epiphysis. Along the edge of the articular cartilage marked proliferation of cartilage and bone takes place which is continued into the synovial membrane. The entire synovial sac is dilated, and the joint ligaments are relaxed and later may ulcerate. Spontaneous dislocations may occur. Marked peri-articular edema occurs; whether this is

due to a tear in the capsule allowing the infiltration of fluid from within the joint or is due to a vasomotor disturbance is not determined.

Roberts systematically classifies the pathologic changes as follows:

1. A chronic asthenic hyperemia of the synovial membrane—a hydrarthrosis.

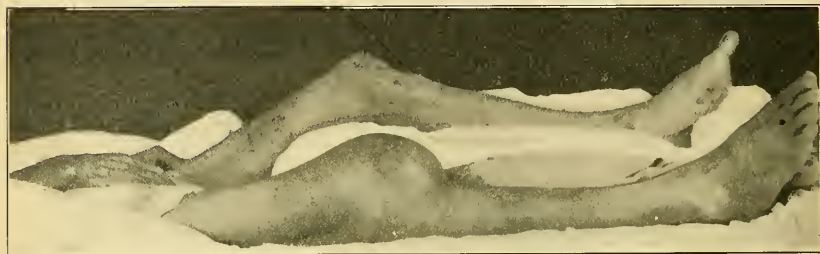


FIG. 533.—ATAXIC KNEE-JOINT.



FIG. 534.—ATAXIC ANKLE-JOINT.



FIG. 535.—ATAXIC ANKLE-JOINT.

2. An interstitial atrophy of the epiphyses.
3. A fungous or rarefying epiphyseal hypertrophy.
4. The formation of osteophytes and bony stalactites.

Symptoms.—The onset of the arthritis may occur before the ataxia, but oftener the symptoms develop after signs of the ataxia are present. The

onset is usually sudden, without any history of trauma to account for the condition. Marked peri-articular edema extending well above and below the affected joint, superficial venous engorgements, and tenseness of the skin follow shortly after the onset. This swelling may pit on pressure or may be very firm. The pain may be erratic, paroxysmal, or constant and there may be exquisite tenderness to pressure. In spinal cases, pain and sensitiveness may be present over certain vertebrae, with an aching distress over which ice develops a feeling of burning.

The course of the affection is varied and essentially chronic. With occasional exacerbations years may elapse before the disease becomes matured. Spontaneous recovery may be abrupt and rapid, or atrophy and absorption of the cartilages with proliferation of osteophytes may result in total destruction of the articulation. Suppuration has been observed, but does not form an essential part of the disease.

The muscles become rapidly and extensively wasted, and respond only to galvanic currents of high power (thirty cells or more).

Diagnosis.—In the earliest stages, before the appearance of the spinal or cerebral lesion, it is impossible for the most acute clinicians to distinguish these affections from some of the ordinary types of acute articular rheumatism. According to Charcot and others, they are to be recognized by the limitation of the affection to the joints of the palsied members, their relation in time to hemiplegia or other nervous lesion, and the coexistence of other trophic disturbances, as dystrophy of the nails, muscular atrophy, etc.

From tuberculous osteitis of the joints they may be distinguished by the absence of reflex pain, muscular spasm, and abscess formation; and from malignant disease of the joints by the anamnesis and course of the disease, and by the presence of central or peripheral disturbance.

Prognosis.—Without treatment the affection is self-limited after a variable period, but repair to the lesion is impossible, and apparent diminution in the deformity is usually due to the disappearance of effusion in and about the articulation. If the nervous lesion can be controlled or cured, recovery may promptly follow, as in the cases recorded by Weir Mitchell.

Treatment.—The treatment consists in limiting or overcoming the central nervous lesion by absolute rest, the use of tonics, iodid of potassium or ammonium in moderate doses, and full doses of strychnin by hypodermatic injection. Locally the use of ice, massage, and the application of a well-

applied roller bandage or pressure sponges will afford the greatest comfort and relief.

Powerful galvanic currents through the joints and reversed galvanic currents have been recommended by Weir Mitchell. If the hydrarthrosis be excessive, aspiration or aseptic incision may be performed. In moderate cases supporting apparatus will improve the local condition. Good results in three cases have followed arthrotomy and permanent irrigation as reported by Lotheissen. When the disease is far advanced, excision or amputation is indicated and is often followed by good results.

Syringomyelia.

The arthropathies of syringomyelia so often closely simulate those of locomotor ataxia that they deserve special mention. They usually occur after the thirtieth year, and are more frequent in males than in females, since syringomyelia attacks two males for one female. Thus, of the 35 cases of joint affections in syringomyelia analyzed by Graf, 26 were males. Arthropathies occur in not less than 10 per cent. of the cases, and whereas in tabes from 75 (Schrotter) to 80 (Graf) per cent. of the affected joints are those of the lower limbs, in syringomyelia the articulations of the upper limbs are generally affected. The frequency of arthropathy in syringomyelia is estimated by Schlesinger to be about 20 to 25 per cent. His statistics showing the distribution of the affection are as follows:

Shoulder, ...	29 cases
Elbow, ...	24 "
Wrist, ...	18 "
Hip, ...	4 "
Knee, ...	7 "
Foot, ...	7 "
Other joints, ...	8 "
	97 cases

N. A. Sokolow reports a case of syringomyelia in which the sterno-clavicular joint was involved. Thus, of 51 joints affected in the 35 collected cases, 39 were in the upper and 12 in the lower limbs, a difference readily explained by the fact that in syringomyelia the cervical and upper dorsal portions of the cord are those chiefly affected. The affection occurs most frequently in persons who use their arms to excess, as tailors, butchers, etc.

Pathology.—The pathologic changes which occur in the arthropathies

of syringomyelia resemble to some degree those seen in arthritis deformans. Two forms of the disease may occur—the hypertrophic and the atrophic forms. In the hypertrophic type there are marked proliferation and osteophytic formation of the head of the bone, which extends to the shaft and the adjoining soft parts, producing enlargement of the bony ends of the affected joint. This is accompanied by effusion, and by relaxation of the capsule and tendons of the joints, producing increased mobility and a tendency to dislocation. Marked edema of the extra-articular structures occurs. When the joints of the lower extremity are affected, destruction of the cartilages results from pressure. Sequestrum formation is occasionally observed. The atrophic type is characterized by rarefaction of the bone even to complete disappearance of the articular surfaces, which in shoulder-joint disease resembles very much the condition found in “*caries sicca*.” Spontaneous dislocations are very liable to occur and may be the first symptoms of syringomyelia. Fractures of the bones near the affected joint are occasionally observed. The disease may be so extensive, especially in the shoulder-joint, that the entire head and upper part of the shaft of the humerus may entirely disappear.

The central lesion of syringomyelia is characterized essentially by the formation of a cavity with gliomatous walls in the gray substance of the spinal cord, or a simple dilatation of the central canal, which is probably a congenital condition and due to defective closure of the tube. The cord may present throughout its whole length an epitome of the gliomatous process in all its various stages.

Symptoms.—The condition may develop suddenly, and the first symptom of the disease may be a dislocation, which at first is thought to be traumatic, but on careful investigation it is found that other symptoms of syringomyelia are present. There may be prodromal signs, as marked localized and referred pains about the affected joint. The course of the arthropathy is generally much slower than that of Charcot's disease. There is usually to be obtained a history of general symptoms of syringomyelia to which the patient has paid no especial attention. These may consist of deformities of the fingers, changes in the nails, scoliosis, paresthesia, partial or complete thermic and pain anesthesia, more often confined to the upper extremities. There may be a history of continued headaches and some ocular symptoms. The patient may give a history of gradually increasing weakness, swelling, pain, increased mobility, a recurrent displacement of the affected joint or joints extending over a period of years, to which, however, he has given little attention

until the acute symptoms and increased disability caused him to seek treatment. There is generally a history of injury immediately preceding the onset of the joint symptoms. Examination of the affected joint shows marked enlargement of the peri-articular structures, with atrophy of the muscles above and below the affected joint. There may be evidence of extravasation of blood in the tissues above the joint, dilatation of the superficial veins, and the overlying skin may be smooth, tense, and glazy. There is usually increased mobility of, and marked effusion in, the joint. The ends of the bones are usually enlarged, distinctly palpable, and there may be a dislocation present, which, however, does not interfere to any marked degree with motion, does not cause pain, and may be reducible by the patient. Sequestrum formation and fistulas are very frequent in cases of long standing.

One or more joints may be simultaneously affected. The course of the arthropathy is more chronic than it is in locomotor ataxia, and the initial disease may last for twenty or twenty-five years. The coexistence of arthropathy with syringomyelia will be accounted for by the discovery of postmortem indications of neuritis and atrophy of the peripheral nerves.

Syringomyelia, says Bruhl, has its own proper symptomatology from which a clinical diagnosis may be made.

Diagnosis.—The presence of an arthropathy of long duration, following injury confined to the upper extremity, with the general symptoms of syringomyelia should make the diagnosis evident.

Prognosis.—The prognosis for the arthropathy is very unfavorable. While the course of the disease may be extremely rapid in some cases, yet in the majority the pathologic changes in the joint may be so slow that its function is not materially interfered with for years.

Treatment.—Operative interference has not, as a rule, been followed by very favorable results. Slight operations, as the removal of sequestra and the cureting of fistulas, may generally be accomplished without anesthesia. If the joint becomes infected, arthrotomy, thorough irrigation, and drainage may be tried, but in most cases this will be found to be ineffectual, requiring resection or amputation. Operative measures, except when urgently demanded, should be limited to the aspiration of effusions under tension and the removal of sequestra. Tight bandaging will prevent reaccumulation of the effusion, and in all cases the joints should be protected by a suitable orthopedic apparatus, to prevent dislocations and to aid in the functional use of the joint.

CHAPTER XXIV.

UNILATERAL DEVELOPMENT.

The occurrence of atrophy or hypertrophy of a portion or a half of the human body is of interest to the surgeon from a practical as well as from a scientific standpoint.

From the *Silpi Sastri*, the earliest known Sanscrit manuscript, Treatise on the Fine Arts, to the most modern treatises upon anthropometry, the asymmetry of the human body has been recognized, and attempts have been made to deduce the exact proportions of the perfect human form. Everything tends to establish the fact that the human type of to-day is identical with that deduced from observation of the most symmetric ancient statues. Quetelet and others recognized the existence of a central or typical form of man, *l'homme moyen*, as the *mean* result of large numbers of actual measurements of living men. Any deviation from this may be considered as asymmetry. Atrophy is most common, although unilateral hypertrophy does sometimes occur.

That this tendency to asymmetry is not confined to man is illustrated by the letter of Professor Joseph Leidy, in which he says: "In the course of my studies in zoology and comparative anatomy I have had occasion, almost incessantly, to notice more or less abnormal symmetry, in contradistinction to that which must be considered normal."

The medicolegal importance of this subject has of late received much attention, particularly as it concerns inequality of the lower extremity. Measurements have been made by Hunt, Cox, Wight, and Morton. The examination of boys in institutions bears testimony to the same fact. Thus, the measurements made by Morton showed inequality of the limbs in 272 out of 513 boys, the difference ranging from one-eighth of an inch to one inch and five-eighths. The remaining 241 showed no appreciable variation in length. It was also noted that in none of the 292 boys suffering from inequality had there been any bone or joint disease or fracture.

More recent investigation shows even a larger proportion of inequality, and in some of the normal schools where my personal attention has been called

to the subject I have found that nearly 70 per cent. of the boys had inequality of the limbs; and of these all but 4 per cent. were short on the left side.

Roberts found by a series of measurements in skeletons that a difference existed in the length of corresponding bones of the two thighs.

In the report published by Garson on the result of the measurement of seventy skeletons of various ages, sexes, and races, it is shown that in 10 per cent. only were the limbs of equal length.

In only five out of eleven skeletons measured by Dwight were the femora equal in length. Variations in the lengths of the tibiæ were also found.

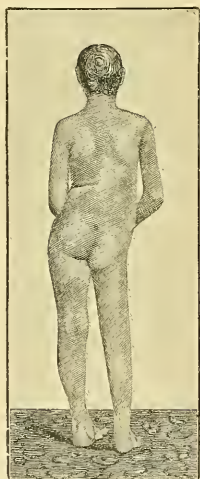


FIG. 536.—UNILATERAL DEVELOPMENT. LEFT LEG.

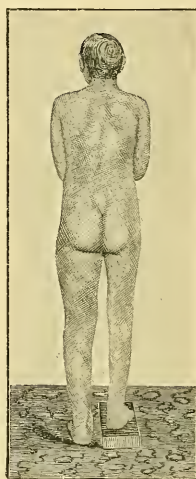


FIG. 537.—SAME, CORRECTED.

In some instances there is also an increase in the volume of the part. Asymmetry of the upper extremities has also been observed by Hartwig and Poncet. The inequality may be uniform throughout, as in a girl of twelve measured by the author, in whom there was a difference of one-fourth of an inch in every measurement upon one side of the body.

Etiology.—Various causes have been assigned, among which may be mentioned a neuropathic disturbance, a former hemiplegia, a premature synostosis of the epiphyseal cartilages, a pathologic lengthening following traumatism. One side, usually the right, may be *ab initio* the stronger, or the inequality may be due to the passage of a pure arterial current to one side.

For unilateral development of the lower extremities a simpler and equally satisfactory explanation may be found in the fault of standing upon one foot in the attitude of fatigue. This leads to an increase in the circumference and length of the advanced limb, with a condensation and shortening of the limb which supports the weight of the body. In time, if continued, this leads to a real inequality of from one-fourth to three-fourths of an inch in the length, with a corresponding difference in the circumferences. The long limb would be the hypertrophied one, the short one being comparatively normal.



FIG. 538.—UNILATERAL DEVELOPMENT SHOWING EXAGGERATION OF DEFORMITY, BY BLOCK ON WRONG SIDE.

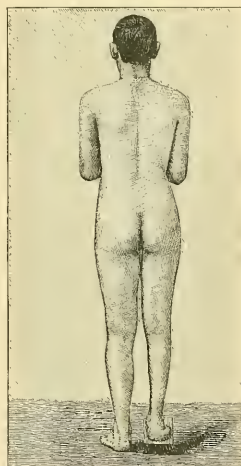


FIG. 539.—UNILATERAL DEVELOPMENT SHOWING CORRECTION OF DEFORMITY, BY BLOCK ON RIGHT SIDE.

Symptoms.—The inequality of the lower extremities produces pain, lateral curvature, and a limp which may be confused with coxalgia or infantile paralysis. The pains are usually neuralgic in character in the lumbar, inguinal, or anterior femoral regions. Occasionally they follow the distribution of the sciatic nerve. As a result of the lateral curvature in the lumbar region there follow congestion of the spinal veins, occipital headache, and neurasthenia, all of which are most marked in males. Upon inspection of the body the changes in the gluteal folds are apparent, the fold on the side of the long limb being higher. The pelvis may be twisted upon its axis also, and Bar-

well has observed three forms of pelvic malposition,—obliquity of the pelvis, amesiality, and version,—all of which are productive of lateral curvature.

Diagnosis.—The difference can usually be recognized upon inspection, but the amount of inequality of the lower limbs can be determined by blocking up the short limb until it is made equal in length with its fellow. A better and more convenient way is by means of a special apparatus devised for the



FIG. 540.—AUTHOR'S MEASURING MACHINE FOR INEQUALITY OF LOWER EXTREMITIES.



FIG. 541.—SAME WITH LIMBS EQUALIZED.

purpose, the top of which contains two movable platforms upon which the individual stands. The short leg is elevated until the folds of the buttocks are level.

Treatment.—The treatment consists in restoring the symmetry and equilibrium by artificial means. An attempt should always be made by special exercises to develop specially the short limb.

CHAPTER XXV.

RICKETS; KNOCK-KNEE; BOW-LEGS.

RICKETS.

Rickets is a constitutional disease of infants, acquired through malnutrition, characterized by impaired nutrition and alterations in the normal growth of the bones, and terminating spontaneously after a longer or shorter period.

Synonyms.—*English*, Rachitis; Rhachitis; Morbus Anglicus; Morbus Puerilis; Articuli Duplicati. *French*, Rachitisme; Novure; Maladie Anglaise. *German*, Englische Krankheit; Doppelte Glieder; Zweiwuchs. *Italian*, Rachitide. *Spanish*, Raquísis.

The term rickets here used, the one popularly employed for nearly three centuries, is derived from the Saxon "rick," meaning a hump or elevation, from a Dorsetshire verb "rucket," to breathe laboriously, as suggested by Trousseau, or from the Norman word "riquets," applied to deformed persons. For scientific purposes, the term rachitis or rhachitis is more correct, the former spelling having the preference, the term being derived from the Greek word *ῥάχις*, "the spine," and *itis*, "inflammation," by the celebrated anatomist Glisson.

Etiology.—The disease is universal, but is most common among the poor in the larger cities. It is much less frequent in the large cities of this country than in Berlin, Vienna, or London, where from 50 to 80 per cent. of all children at the clinics are more or less affected. In this country it is very common among the negroes, Italians, and Portuguese. It is said to be comparatively rare in Canada, Greece, and Scandinavia; and, according to Ashmead, it does not exist in Japan. It is sometimes observed in the country, and is not infrequent among the children of the wealthy, where it often assumes the form known as acute rickets, in reality a manifestation of scurvy. The severest cases occur in winter, from hygienic causes rather than from seasonal variation. The disease affects male and female children about equally. From the obscurity of the etiology of this affection several theories have arisen. For a description of these the reader is referred to works upon pediatrics.

Rickets is usually an acquired affection due to certain known predisposing

and exciting causes, under the influence of which almost any child may have rachitis. The exceptional instances are those in which the tuberculous or syphilitic diathesis is present and antagonistic, and these deserve special consideration. Rickets and tuberculosis are considered exclusive, but tuberculous meningitis is, in rare instances, associated with rickets. The identity of the tuberculous diathesis and rickets was supported by all the older writers. There is, however, no direct relationship between the two affections. A phthisical parent may bear rickety children, or rickety children may become tuberculous, but children with marked tuberculous diathesis rarely, if ever, become rickety, nor is it common to find rickets in a family where the other children are tuberculous. I have observed exceptional instances in which children at first rachitic later developed tuberculous bone disease from an inherited diathesis. The belief in the identity of rickets and syphilis is as ancient as the history of medicine itself. Rickets may affect the offspring of syphilitic persons, but severe rickets does not occur in syphilitic children. The belief that rickets is only a manifestation of congenital syphilis is certainly incorrect. Syphilis may act as a predisposing cause to rickets by impairing the constitution. The anatomic lesions in the two conditions are quite distinct. Syphilitic bones very rarely, if ever, present the spongy tissue peculiar to rickets, and rachitic bones never exhibit the multiple osteophytes of syphilis. When syphilis precedes rickets, it sometimes produces those osseous deformities which have been designated syphilitic pseudo-rachitis. There is no evidence that the disease is ever transmitted. Anything which impairs the general health or seriously interferes with the assimilative power may be considered as a predisposing cause of rickets, and improper food is the exciting cause. Want of sunlight, impure air, and insufficient exercise are important factors, but given a healthy mother with an abundance of milk, rickets may be escaped, no matter what the character of the surroundings. Malnutrition through the use of improper food is the most common exciting cause. Whatever unfits the mother's milk for the nourishment of her child requires consideration. Gold cannot buy wisdom, and wealth, through ignorance and indolence, vies with poverty, through need and necessity, in producing milk which is poor in quality and deficient in quantity. The use of artificial foods is said to cause rachitis by deprivation of fats and phosphates. This may also be true of the mother's milk. In cases with digestive disturbances children may be deprived of these elements through faulty assimilation. Too early weaning is not so common a cause as too late weaning. Through some false ideas of preventing

conception, or through absolute ignorance, children nursed from eighteen to twenty-eight months are particularly liable. The occurrence of pregnancy during lactation, and too frequent pregnancies, are likewise frequent causes. The possibility of the occurrence of rickets after any acute disease, particularly malarial fevers, should not be overlooked.

Four varieties of rickets may be distinguished:

1. Intrauterine rickets.
2. Infantile rickets.
3. Adolescent rickets.
4. Senile rickets.

Intrauterine Rickets.—Since Ritter described and figured the first authentic specimen of congenital rickets numerous observers have recorded similar examples.

Two varieties of intrauterine rickets are recognized—*fetal* rickets and *congenital* rickets. Fetal rickets is synonymous with achondroplasia and chondrodystrophia foetalis. It is a pathologic process of early fetal life, beginning from the third to the sixth month of intrauterine life and terminating before full term. In some respects it resembles true rickets: the head is large, the ribs are beaded, the epiphyses are enlarged, and the shafts of the long bones are curved. It differs from congenital rickets in its early onset, atrophic changes in the cartilage of the epiphyses, with too rapid ossification and periosteal hypertrophy. The body is abnormally long in proportion to the limbs, a condition resembling the dachshund among canines. Fetal rickets is in some obscure manner allied to the condition known as cretinism, and the opinion has been expressed that the cases of rickets which have been described are more properly to be regarded as examples of fetal cretinism. There is, however, no mental deficiency in fetal rickets.

The treatment consists of the use of general massage, manipulations to increase the range of motion in the joints, and the use of braces for a time to limit any increase of bowing which would result from the disproportionate weight of the body upon the diminutive legs.

Congenital rickets is far from uncommon in newborn infants whose parents have been living in bad hygienic surroundings during pregnancy. Swartz out of 500 infants born at the Vienna Clinic found 80.6 per cent. with typical rachitic changes. Doubt has been expressed as to the identity of the lesions found with the post-natal disease. Congenital rickets appears in the later months of pregnancy and develops subsequently to birth. That they are

cases of true rickets would seem to be established by the specimen recorded by Ballantyne, which likewise tends to confirm the opinion that the histologic characters of true intrauterine or congenital variety and extrauterine rickets are identical, by exhibiting in the same fetus characters peculiar to both fetal and congenital rickets.

Infantile rickets seldom appears before the seventh or ninth month, most frequently between the seventh and eighteenth month, and rarely after the second year.



FIG. 542.—INFANTILE RICKETS, SHOWING BOSSY FRONTS, LATERAL THORACIC GROOVES AND "RACHITIC ROSARY," LARGE ABDOMEN, AND DEFORMITIES OF EXTREMITIES.

Adolescent rickets affects persons about puberty and is usually associated with albuminuria. In the cases reported by Clutton and Drewett, the affection was identical with the infantile variety. This form of rickets is fairly common, and the writer has observed it commencing as late as the eighteenth year. The cause in the observed cases was apparently faulty nutrition. In one remarkable instance bow-leg began in a youth of eighteen from using a liquid diet on account of a supposed stricture of the esophagus.

Senile rickets, first described by Reeves, occurs during adult and advanced life. Durham has collected 145 cases, most of which were associated with childbirth. It is rarely met outside of the Rhine provinces, and is frequently confounded with osteitis deformans.

Pathology.—The most important pathologic lesions are in the bones, and especially in the epiphyseal junctures of the long bones and the ribs. In normal bony growth the development depends upon three conditions: the lengthening from cells furnished by the cartilages between the epiphysis and diathesis, the thickening from cell proliferation by the inner layers of the periosteum, and the according enlargement of the medullary canal by the loss of the inner bone layers. This growth in rachitic bones is excessive and irregular, while the actual ossification is wanting or imperfect. The bone-tissue, owing to the sudden growth and irregular calcification, is irregular and spongy, and unfitted to bear the body-weight. The peculiar enlargement of the joints is, of course, owing to the cartilaginous over-production and the flattening of the soft bone by the body-weight. The medullary canal is larger and the inner bone layers are spongy. The medulla is congested, and if fat is



FIG. 543.—SPECIMEN BOW-LEGS.

present it may be absorbed and a species of osteitis be present. The cartilage at these localities between the shaft and epiphysis, normally represented by two narrow bands one or two millimeters in thickness, is greatly thickened, from five to fifteen millimeters in width, reddish-

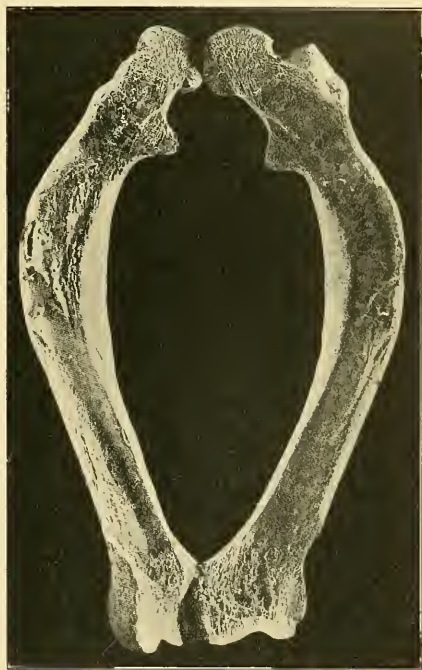


FIG. 544.—BOW-LEGS, SHOWING STRUCTURE.

gray, translucent, irregular in outline and softer, and the entire epiphysis is enlarged and softened. The microscopic appearance shows changes at the area of normal ossification. The columns of cartilage cells are irregular in shape and size, and many cells show absence of true ossification, while the medullary spaces, enlarged in size and irreg-

ular in shape, encroach upon the area of calcification and are filled with "osteoid tissue." The periosteum is thickened and infiltrated, as is also the underlying bone structure, with spongoid, jelly-like fluid. The result of these changes is imperfect or delayed ossification, and the deposit of lime salts is arrested. The relation of organic to inorganic matter in the bones is very much increased, the diminution of calcareous salts being as low as 25 to 35 per cent. In the cranial bones large areas of imperfect ossification are met, giving rise later to areas of atrophy and premature hyperostosis. Later, the deposit of lime recommences and advances with undue rapidity, producing a condition of eburnation or petrification in the bones. The pathologic anatomy of rickets may therefore be regarded as a hyperemia of all the bone-forming structures as the primary lesion. The spleen, liver, and sometimes the mesenteric glands, are enlarged. Catarrh of the alimentary and respiratory passages is usually present. The brain is usually hypertrophied, and, with the membranes, is unusually vascular. The voluntary muscles are pale, soft, and flabby, and the ligaments are soft and relaxed. The blood-changes are usually those of anemia. There is leukocytosis and decrease in the number of red corpuscles, some of which are nucleated. The leukocytosis consists of a special increase of mononuclear elements and there may be myelocytes.

Symptoms.—The symptoms of rickets are well marked and characteristic, and may for convenience be included under three divisions: (1) Incubation; (2) deformation; and (3) recovery.

Incubation.—Preceding the period of bone change, there are certain characteristic symptoms which are liable to be overlooked. Loss of appetite, occasional vomiting, impaired digestion, flatulence, constipation alternating with diarrhea, the stools being mucous, green, often frothy and extremely offensive, indicate disturbances of digestion which frequently precede but are not invariable precursors of this affection. The skin is pale and at first generally moist, afterward hot and dry; the flesh is plump, though flabby, the abdomen distended, and the anterior fontanel depressed. Associated with these digestive disorders are two symptoms which are characteristic of the first stage—local sweatings and nocturnal fever, the early recognition of which will be of the greatest importance. The local sweatings are chiefly confined to the head, neck, and upper part of the chest and back. These portions are cold and damp, in marked contrast to the rest of the skin, which is hot and dry. They occur usually during sleep, but may be induced by motion or exercise.

Upon the forehead, face, and neck the perspiration appears in large, clear drops, and is often associated with a copious eruption of miliaria vesicles. Associated with this local sweating the skin is hot, dry, and uncomfortable, leading to great restlessness and a disposition to kick the clothes off at night, even in the coldest weather. The pillow is thus often wet with perspiration, while the limbs are hot, dry, and uncovered.

Deformation.—The commencement of morbid changes in the bones is marked by general hyperesthesia or tenderness, first exhibited by signs of uneasiness upon motion; the tenderness increases until the slightest involuntary movement causes pain, even the approach of persons produces fear and aversion, and the child prefers to remain quiet, motionless, and alone. The veins upon the head and scalp are enlarged and prominent, general hyperemia of the cranium and scalp exists, and the carotid arteries and jugular veins are disproportionately large. The digestive derangement continues; constipation is not uncommon, and diarrhea and constipation frequently alternate; the urine is abundant and loaded with phosphates, the appetite is voracious, the abdomen is distended, the flesh is soft, flabby, and in some instances emaciated, and the skin pale.

These prodromal symptoms are prolonged into, and may even increase in severity during the stage of bone lesion. The changes in the bones which lead to deformity may be divided into three stages:

1. The stage of congestion or invasion.
2. The stage of softening or deformity.
3. The stage of hardening or sclerosis.

In children in whom the disease has commenced at the beginning of teething, about the sixth or eighth month, the final stage is usually reached about the third year.

All the bones are simultaneously affected, but the order in which deformity usually appears is, first, the trunk; second, the head; third, the extremities.

Trunk. Among the first bony lesions are the changes in the epiphyseal junction of the ribs, forming the so-called rickety rosary, a series of bead-like enlargements easily felt beneath the skin. Important changes occur in the thorax. The transverse diameter being sometimes less than the antero-posterior, the bodies of the ribs are bent, forming a groove just outside the junction of the cartilages; the lower border of the thorax is pushed out by the enlarged liver and spleen, forming a transverse groove, the so-called Harrison's groove,

passing outward just below the fold of the pectoral muscle. The sternum projects forward like the prow of a ship, forming the so-called pigeon-breast or chicken-breast. Attention has been particularly directed to diastasis of the abdominal recti muscles by Francine. Changes also occur in the spinal column; an antero-posterior curve, a simple exaggeration of the normal curves through weakness and long-continued sedentary position, being most common. Lateral curvature is also a common deformity, and lordosis, as a compensatory affection, sometimes occurs and may persist. The lordotic appearance is increased by the large size of the abdomen. Changes in the pelvis occur from the sedentary position and from the pressure of the heads of the thigh bones. Illustrations of this are common in all obstetric treatises. The abdomen is

greatly enlarged from several causes—contraction and depression of the diaphragm, from the diminished capacity of the thorax, increased shallowness of the pelvis, tympany, and enlargement of the liver and spleen.



FIG. 545.—PHOTOGRAPH OF CASE OF RACHITIC SPINE.

Head. The head of a rickety child is large and misshapen, and the fontanels, particularly the anterior, which normally should close about the eighteenth month, remain open until the end of the third or fourth year and ossification may not be complete until the termination of the sixth or even the ninth year.

There are two varieties of skull typical of rickets—the oblong head, such as is met in negro children, and the square head, the more

common variety, which seen from above is rectangular, the *caput quadratum*. The forehead is high, the frontal and parietal protuberances prominent, and the comparative smallness of the face is characteristic. Another peculiarity is imperfect ossification, particularly in the parieto-occipital regions, the so-called soft occiput, or *cranio tabes*. This deficiency of ossification is preceded by thickening and softening of the bone. These softenings are round or oval spots, from one to twenty-five in number, situated just within the sutural margins, and give the sensation of an orifice closed by cartridge paper. The normal process of dentition is ordinarily retarded, and the eruption is irregular in time of appearance and position, and attended with great pain. Teeth which have appeared decay early, and at eighteen months or two years very few teeth

may remain. Cerebral development in rickets is usually retarded; the intellect is dull.

Extremities. The alterations in the long bones occur early, commencing



FIG. 546.—RACHITIC KYPHOSIS. LATERAL VIEW.

first and affecting most seriously those parts which have a thin covering of soft parts, such as the wrist, elbow, knee, and ankle. The increase in size of the epiphyses is real and gives an appearance of an additional joint, the

victims of this affection sometimes being spoken of as double-jointed. The length and circumference of the shaft are also less than normal. From softening and imperfect ossification of the bones, any or all of the long bones may be bent or twisted. These deformities have been ascribed to muscular action, gravity, the weight of the body, and atmospheric resistance. Most of these deformities may be accounted for by the weight of the body, gravity, and the peculiar position occupied by the child. The weight of the body upon the softened neck of the femur



FIG. 547.—RICKETS, SHOWING DEFORMITY OF CHEST.



FIG. 548.—KNOCK-KNEE AND BOW-LEGS.

often produces coxa vara, a condition fully described elsewhere. Subluxation of the inner end of the clavicle has been observed. Flat-foot is present in almost all cases of rickets. It occurs usually before the seventh year, either alone or associated with knock-knee. Associated in certain cases with the deformity is a pseudo-paraplegia, known as Parrot's disease, from excessive tenderness of the periosteum, which prevents the child from walking, and sometimes from standing. The muscles are atrophied and weak, but there is no permanent nervous lesion. The electric reactions are normal, the reflexes are not exag-

gerated, and the pseudo-paralysis is due to a periosteal tenderness of the muscular insertions and muscular weakness.

Complications.—Children affected with marked rickets are especially predisposed to certain diseases, to one of which death is usually directly attributed. These include laryngismus stridulus, convulsions, chronic hydrocephalus, bronchitis, and diarrhea. These belong more particularly to pædiatrics and may be omitted here.

Recovery.—Though death often occurs from some intercurrent affection, the disease frequently terminates favorably, the recovery being perfect. All the symptoms subside and gradually disappear, the bones become exceedingly thick and very hard, the muscles short, thick, and very firm; the epiphyseal enlargements diminish, and serious deformities of the long bones and throat diminish remarkably, and may entirely disappear within a few months.

Prognosis.—The tendency of uncomplicated rickets is to spontaneous recovery after a variable period. The danger lies in the complications—degeneration of the viscera, catarrhal affections of the respiratory passages, diarrhea, hydrocephalus, and, in very rare cases, laryngismus stridulus. Under efficient treatment the disease is very tractable, and the prognosis as to life is good, unless some complications arise. If the disease be early arrested, the bony deformities and the kyphosis and lordosis all tend to diminish, but the full stature is seldom attained by adults who have been affected in early life. Such patients may subsequently become marvels of endurance and strength and live to a great age.

Treatment.—The treatment of rickets should be hygienic, dietetic, and medicinal.

The hygienic treatment should include the selection of a proper diet and the improvement of the entire surroundings of the child. A daily bath in tepid salt-water, with vigorous rubbing, should be given, and the child, warmly clad in warm woolen clothing and carefully wrapped, should spend the greater part of the day in the fresh air and sunshine on all except windy days. A flannel bandage about the abdomen should always be worn, summer and winter.

Frequent pregnancies and nursing a child during pregnancy are important etiologic factors to be overcome. If a nursing woman become pregnant, or the mother is unhealthy, or cannot, from other cause, nurse the child, the child should be artificially fed. If the child be bottle-fed, the most rigid system of cleanliness must be enforced to maintain sterilization of the food. If the patient reside in a cold, damp locality, a change to the dry, bracing air of mountain, country, and especially seashore, is often of great benefit. Seashore hospi-

tals, established both in this country and abroad, are excellent resorts for rachitic children, and the "day nurseries" in our large cities accomplish much good by the proper feeding and care of the children. The bowels should be regulated by castor oil, olive oil, "rhubarb and soda mixture," or compound licorice powder. The diet of a rachitic child is most important. If there is any tendency to scurvy, orange juice, raw scraped apples, fresh grape juice, or grapes without skins or seeds will be found of value. For full details of proper diet, the reader should consult works upon diseases of children.

Fish should be largely used by nursing mothers. Indeed, Ashmead ascribes the absence of rickets in Japan, among other reasons, to the large use of fish, crustaceal and iodized seaweed, oils of fish, blubber of whale, and especially loach, by nursing women, the children being all breast-fed and suckled for a very long period, the Japanese women having also an enormously large supply of milk.

Medicinal treatment is secondary in importance to the foregoing. The general condition should be improved by cod-liver oil, which is considered by many a specific, and which has long been a common remedy on the shores of the Baltic. It may be given pure, in teaspoonful doses, or, what the writer prefers, in an emulsion with the lacto-phosphate of lime. The latter formula is:

R. Ol. morrhue, ... ʒvj.
 Syr. calcis lacto-phosphatis,
 Aq. calcis, ... āā ʒiij.
 Sig.—ʒj or ʒij three times a day.

Another excellent combination is with maltine, or maltine and syr. calcis lacto-phosphatis. It may also be rubbed into the legs, arms, and abdomen at bedtime. Syrup of hypophosphites is another excellent remedy, and may be used in summer to alternate with the oil. Iron is highly recommended by all authorities, and may be given in the form of hypophosphite, the wine of iron, the citrate of iron and quinin, or, preferably, the syrup of the iodid of iron. Phosphorus has been recommended, and reports are favorable in this, as in all wasting diseases of the bone. It is usually given to children in $\frac{1}{120}$ -grain doses, dissolved in oil, three times a day. A more palatable form is Thompson's solution, the formula for which is as follows:

R. Phosphori, ... gr. j.
 Alcohol. absolut., ... ℥ cccl.
 Spt. menth. pip., ... ℥ x.
 Glycerinæ, ... fʒij.

Sig.—For a child two to four years, 6 minims, t. i. d., increased to 10 minims.
 Strength gr. $\frac{1}{20}$ to ʒj.

The results of phosphorus treatment are contradictory, and the writer has more confidence in the other drugs mentioned.

The surgical treatment includes the correction of knock-knee, bow-legs, and anterior bow-legs. For dislocation of the clavicle, Gibney advises the subcutaneous injection of alcohol around the articulation and binding the parts with a roller bandage.

KNOCK-KNEE.

Knock-knee, or genu valgum, is that deformity in which the knee is thrown inside a perpendicular line drawn from the head of the femur to a point midway between the malleoli; in other words, where the bones of the leg form an abnormal angle opening outward with the bones of the thigh—an abduction contracture.

Synonyms.—*English*, In-knee. *French*, Genou en dans; Genou Cagneux. *German*, X-Bein; Knickbein; Ziegenbein; Bäckerbein; Knieng; Kniebohrer; Schemmelbein. *Italian*, Ginocchio Torto all' Indentro. *Latin*, Genu Introrsum. *Greek*, Entogonyancon. *Spanish*, Rodélla al interno.

Occurrence.—The deformity is frequently met in surgical practice, but is not so common as bow-legs. Thus, of 6400 cases of general surgical disease in children treated at the New York Orthopedic Hospital and Dispensary, there were 270 cases of knock-knee and 400 cases of bow-legs. In 5860 cases of general orthopedic affections treated at the Orthopedic Dispensary of the Hospital of the University of Pennsylvania, 77 were cases of knock-knee, and 169 were cases of bow-legs. Boys appear to be more frequently affected than girls.

Congenital cases, though rare, do occur, and both knock-knee and bow-legs have been observed in the newborn. The extremely rare variety of genu valgum which follows congenital luxation of the patella belongs under this head.

The deformity usually appears when the child begins to walk, between the ages of two and four—*genu valgum rhachiticum infantum*; or about adolescence, between the ages of twelve and eighteen—*genu valgum adolescentium*.

The congenital form is usually the expression of general rickets.

The acquired forms present several varieties, which may be grouped into: (1) Rachitic; (2) Atonic; (3) Paralytic; (4) Arthritic; and (5) Traumatic.

1. The rachitic variety includes almost all the cases occurring during the

first period, and many authorities would include some of those also which occur at puberty, and consider the process a local rachitic one—a form of “latent rickets.”

Rickets softens the bones, weakens the muscles, and relaxes the ligaments, and the superincumbent weight of the body accomplishes the rest. Genu valgum in these cases is simply the local manifestation of a constitutional diathesis.

2. The atonic or statical variety affects individuals of feeble physique about the time of puberty—*genu valgum staticum sive adolescentium*—whose occupations compel them to stand most of the time. Carpenters, waiters, cooks, young bricklayers, and especially bakers, who work in a warm, moist atmosphere, and carry heavy loads of bread, are most liable to be affected. They exhibit no evidence of rickets, but suffer from relaxation of the ligaments and muscles.

The production of this form of genu valgum is usually the result of faulty positions assumed from weakness or fatigue.

The normal human individual stands erect with a certain amount of knock-knee, the femurs form an angle with each other of 15 degrees or more, and an imaginary line drawn from the head of the femur falls outside the center of the knee-joint. To compensate for this the normal internal condyle of the femur is from one-quarter to one-half inch longer than the external.

Children and adults of feeble physique instinctively assume a valgoid position with the knees extended and the feet everted and separated, the so-called “attitude of rest,” a position in which ligamentous is substituted for muscular support, and the limbs placed in a position most favorable for the production of this deformity. Unilateral knock-knee sometimes results from the pressure of the mother’s arm upon the softened bones when the child is carried constantly upon one side. Flat-foot is often associated in this form as well as in the rachitic, sometimes as causative, as a secondary condition, or both may result from the same faulty attitude.

It has been suggested that asymmetry may be an important factor in the genesis of this form of knock-knee.

3. The paralytic varieties are met with in connection with infantile spinal paralysis and in spastic paraplegia.

Trophic disturbances affect the nutrition of the bones, ligaments, and muscles. The bones are more curved, thinner, and softer than normal; the ligaments are relaxed, and the muscles have their equilibrium destroyed, not

from loss of muscular antagonism, but from growth while the part remains in an abnormal position.

4. The arthritic variety includes the few cases which result from destructive disease of the joint, the so-called *genu valgum inflammatorium*, from tuberculous osteitis, rheumatoid arthritis, osteomalacia, osteomyelitis, osteoarthritis, etc.

5. The traumatic form occurs from fractures of condyles of the femur or of the articular facets of the tibia, and in rare cases from over-correction after osteotomy for genu varum.

The chief theories which have been advocated to explain this deformity may be included under three heads: (1) The ligamentous theory. (2) The muscular theory. (3) The osseous theory.

The ligamentous theory considered either that the internal lateral ligament was primarily relaxed, permitting lateral and downward hypertrophy of the internal condyle of the femur; or that the external lateral ligament was primarily shortened, producing pressure atrophy or deficiency of growth of the outer condyle. According to some observers, the *internal* ligaments of the joint, principally the crucial, are largely concerned as causative agents.

The muscular theory assumes either a primary shortening of the biceps popliteus, and tensor vaginæ femoris muscles, or a primary relaxation of these same structures.

The osseous theory assumes a primary rachitic, inflammatory, or other osseous changes in the epiphysis or lower portion of the femur or the upper part of the tibia, producing hypertrophy of the inner portion of the joint, with or without atrophy of the outer portion.

The defective growth of the external condyle has been ascribed to premature inflammatory synostosis of the outer part of the epiphyseal cartilage from excess of pressure. Malnutrition of the epiphyses, the result of central changes having their expression in the epiphyseal cartilages of the knee-joint, has been suggested as a cause.

These theories have been formulated to explain the pathologic findings in genu valgum, but in the majority of instances no one theory will account for the production of this affection. In many cases rachitis is the sole cause; in a large number the statical conditions, with or without rickets, are causative; in others paralysis, local disease, or traumatism, are etiologic factors. In all cases, after the condition is once established, the superincumbent weight of the body is an important factor in increasing the deformity.

Pathology.—The morbid anatomy will depend upon the stage of the affection and the degree of deformity.

In the rachitic form the most important changes are in the bones forming the knee-joint.

The elongation of the internal condyle is both apparent and real; the external condyle is atrophied and sclerosed, and the entire lower epiphysis of the femur is broadened, shortened, and obliquely placed upon the shaft, from the lengthening of the inner side of the lower part of the diaphysis.

In some cases the lower epiphysis of the femur is twisted or rotated out, while in others the upper epiphysis of the tibia is oblique and rotated generally outward, in rare cases inward, and the femur is apparently normal. The shafts of the femur and tibia are bent above and below the joint, and in some cases at the upper part of the shaft of the femur and the lower part of the shaft of the tibia.

The density of the osseous structure depends upon the stage of the morbid process, being a little softer than normal bones during the stage of vascularity, as soft as cheese during the stage of softening, and as hard as ivory in the stage of consolidation.

The articular cartilages are hypertrophied on the outer side and atrophied upon the inner side.

The internal lateral ligament is elongated and relaxed and hypertrophied. The external lateral ligament is contracted, and in some cases the crucial ligaments are atrophied or entirely absent.

The muscles upon the outer side are shortened, and those upon the inner side are relaxed and elongated.

In the paralytic cases the primary changes are muscular; the action of these has already been described.

In the pathologic and traumatic cases the changes are local and primarily osseous, the other structures becoming subsequently involved.

Symptoms.—The symptoms of genu valgum are the deformity about the knee, the peculiar gait in walking, and the secondary deformities which complicate this affection. In standing, the knees are more or less unduly prominent upon the inner aspect, the leg projects outward, and the feet are separated to a varying degree. The in-knee should be examined in the fully extended erect position, or, better, in the extended recumbent position. Preternatural lateral mobility of the articulation is characteristic. Pain on the inner side is not constant, but when present suggests a local inflammatory

process. Flexion of the knee causes almost entire disappearance of the angular deformity, a peculiarity explained by two factors: the obliquity of the articular surface of the condyles and consequent oblique axis of rotation, as in a Charnier joint obliquely placed; and also the outward rotation of the femur upon its own axis. A simpler and more satisfactory explanation is found in the fact that the increase in the internal condyle is only in length and not antero-



FIG. 549.—TILTING OF PELVIS FROM INEQUALITY OF LOWER EXTREMITIES DUE TO BOW-LEGS (Spellissy).



FIG. 550.—SAME SHOWING CORRECTION OF TILTED PELVIS (Spellissy).

posteriorly, and that in flexion the facets of the tibia come in contact with the posterior normal condylar surface.

In unilateral cases obliquity of the pelvis downward upon the affected side, and flexion of the thigh of the sound side, diminishes the inequality of the limbs and modifies what would otherwise be a limp.

In bilateral cases the feet are widely separated, the knees slightly flexed

to prevent them from striking, and with each step the knee deformity is increased, producing a mild half-jerking, half-rolling gait that is characteristic. Flat-foot, lateral curvature, hyperextension of the knee or back-knee are associated as secondary or coincident deformities dependent upon the same cause.

In rare and severe cases, in persons whose muscles are not weak, a compensatory supination or adduction of the foot, a "toeing in," may develop, and, notwithstanding the oblique position of the leg, the sole may be set flat upon the ground.

In single knock-knee a compensatory or accommodative bow-leg of the opposite leg may occur. Elaborate methods for estimating the amount of deformity have been proposed by several writers. The simplest and best method of recording the deformity consists in making an outline tracing of both limbs with the patient seated with the limbs extended upon a sheet of paper, or a lead tracing of the inner side of each limb may be made.

Diagnosis.—The diagnostic points have already been given under the symptoms. It is necessary also to distinguish the varieties. In children the majority will be found to be rachitic, and during adolescence, while the majority are statical, the rachitic diathesis may often be discovered. In paralytic knock-knee the associated nervous lesions distinguish the cause. In severe inflammatory cases the local symptoms of tumor albus will distinguish, and in the traumatic cases the history of fracture or operation and the osseous changes will render the diagnosis clear.

Prognosis.—Parents are frequently assured that children will "grow out of" this deformity, but such is the truth only in the mild degrees. In moderate and severe cases the probabilities are that the affection will remain stationary or grow progressively worse unless treated. Robust health, strong muscles, and recovery from the rachitic diathesis are all favorable to such a termination, but the large number of adults seen in public places who are knock-kneed would seem to prove conclusively that many never recover.

Since the introduction of aseptic osteotomy and improved forms of osteoclasis, cases requiring operation are uniformly successful. In arthritis deformans the prognosis is unfavorable, and the limb may become useless.

Treatment.—The treatment of knock-knee may be considered under three heads: (1) Hygienic; (2) Mechanical; (3) Operative.

Hygienic treatment. The hygienic method of treatment is intended to assist Nature's efforts to correct the deformity, and is most valuable in infantile rachitic cases and in statical cases occurring during adolescence. The

constitutional treatment for rickets, or general tonic treatment, should be begun, and every effort should be made to improve the hygienic surroundings of the patient. General gymnastic treatment is of the highest importance, and a change to seashore or mountain air will often work marvels. The entire lower extremities should be rubbed with bathing whisky, and manipulated every night before retiring. To accomplish the most good, the limb should be grasped above and below the knee and the thumbs be applied upon the inner side of the knee. In this position strong traction should be made with the hands while firm pressure is exerted upon the prominent in-knee. This last may be applied after the child has fallen to sleep. The pressure should be firm, forcible, repeated several times for a few seconds each time, and should not be severe enough to awaken the child or make it cry. This manipulation is of the greatest value, with or without the use of apparatus.

Mechanical treatment.

The treatment by apparatus is employed to limit the progress of the deformity by taking the weight off the limbs, or gradually to correct the deformity by making counter-pressure against the internal condyle. Two methods are employed: that which confines the patient to bed, and that

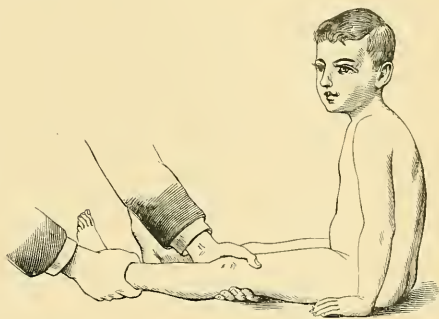


FIG. 551.—MANUAL CORRECTION OF KNOCK-KNEE (Hoffa).

which encourages locomotion. The former has been entirely abandoned in this country. Apparatus is employed before the end of the third year, when, in rachitic cases, the stage of hardening usually occurs, though cures have also been effected in adolescents. The condition of the bones can usually be determined by the age, and also by the elastic or springy feel when gradual manual pressure is applied. In cases in which doubt exists, mechanical treatment can be tried for several months before resorting to operation. Plaster-of-Paris furnishes the simplest and cheapest mechanical appliance.

Some employ a plaster bandage from which an elliptic piece has been removed from the inner side of the knee, and with a splint upon the outer side make traction. Others incorporate metal hinges in the plaster dressing, and after removing a section from the outer and inner sides of the cast, apply

elastic traction by means of rubber bands. These cheap methods are all useful where better apparatus cannot be secured, and have been referred to elsewhere, but it is unnecessary to describe the various forms of appliances devised for the relief of this deformity; the principle of all is identical, the application of counter-pressure upon the hypertrophied internal condyle, but they differ in the method of application.

The retention braces, which are to be worn during the day, are most effective. They consist of two steel uprights carried well up the thigh, attached by a stirrup to the shoe and to a band above and below the knee, jointed at the knee and ankle and having at these two points pressure-pads which make direct pressure against a long rectangular counter-pressure pad attached upon the outer upright about the middle of the leg. They must be fitted to the deformity with bending irons, and as the deformity diminishes they are to be straightened and the pressure increased. These braces can be rendered still more efficient by fixing the knee-joint, and this is strongly to be recommended. It is also important for the first three months to wear an extension connecting the leg braces with a pelvic girdle, until the child has become accustomed to their use, since fracture of the thigh has resulted from falls caused by the awkwardness of the braces.

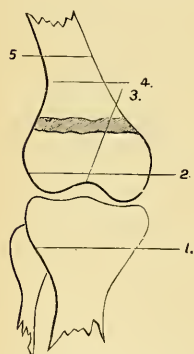


FIG. 552.—LINES FOR OSTEOTOMY.

1, Mayer, Billroth, Schede; 2, Annandale; 3, Ogston, Reeves, Chiene; 4, MacEwen; 5, Taylor.

Manipulation of the limb as described, the retention day brace, and the elastic-traction night brace furnish together a plan of treatment that has proved very curative in the hands of the writer.

Operative treatment. The surgical procedures now employed for the relief of this deformity may be included under the following heads:

1. Tenotomy.
2. Forcible manual straightening.
3. Osteotomy.
4. Osteoclasis.

1. Tenotomy of the biceps and division of the iliotibial band and the external lateral ligament have been performed for the relief of this affection. These operations are now employed only as adjuncts to other methods in paralytic and arthritic cases.

2. Forcible manual straightening, or *redressement brusque*, proposed by Delore and performed by many European surgeons, and designated by Lorenz epiphysiolysis, has not been favorably received in this country. Delore has recorded one death from scarlatina, and Tillaux one from pyemia. The operation consists in forcible manual reduction of the deformity, the limb being bent laterally or over-extended until it snaps and gives way; the lesions being rupture of the external lateral ligament, separation of the external condyle, and fracture into the joint. The bad results of the operation are said

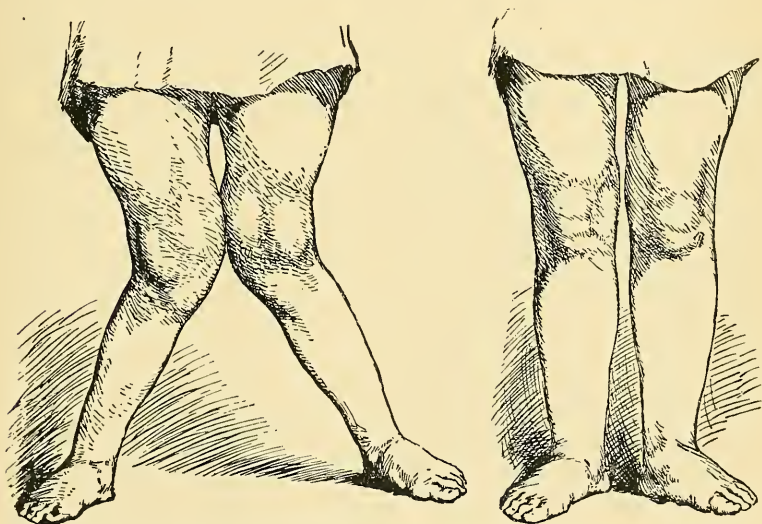


FIG. 553.—DOUBLE KNOCK-KNEE BEFORE OSTEOTOMY (Roberts). FIG. 554.—DOUBLE KNOCK-KNEE AFTER OPERATION (Roberts).

to be arthritis with effusion, severe periostitis, and necrosis, and a weak and lax condition of the joint. The operation is rough and unsurgical, is not entirely safe, and should be abandoned for osteotomy wherever manual correction has failed. In some cases of severe knock-knee, in the stage of softening, rapid manual reduction may with benefit be performed without the occurrence of any of the lesions before referred to.

3. Osteotomy. Encouraged by the antiseptic method, Annandale in 1875 excised a portion of the condyles for genu valgum, and in the same year aseptic osteotomy was introduced by Volkmann, for ankylosis of the knee.

In 1876 Ogston operated for genu varum through a small wound, using a saw, and was followed the same year by Schede.

In 1878 Macewen introduced antiseptic supracondyloid osteotomy, which removed the dangers attendant upon opening the knee-joint, which had been the objection in all previous operations. In 1879 Reeves introduced his extra-articular condylotomy, a modification of Ogston's operation, the object of which was to minimize the danger of opening the joint and to loosen and properly replace the displaced condyle. The lines of the different operations are

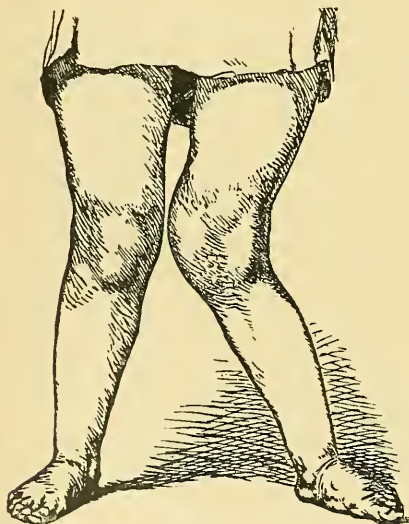


FIG. 555.—KNOCK-KNEE BEFORE OSTEOTOMY (Roberts).

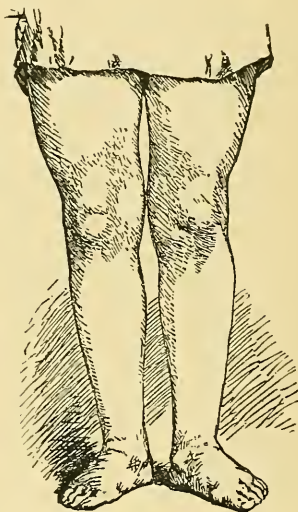


FIG. 556.—SAME, AFTER OSTEOTOMY (Roberts).

given in Fig. 552. The superiority of the Macewen operation is admitted by all, and except in rare cases it is now performed in this country to the exclusion of all others.

Of the different operations for knock-knee the writer's personal preference is for that of Macewen, and this and its modifications are all that will be described.

The technic of osteotomy in general has already been described.

The Macewen operation is performed as follows: The limb having been sterilized at the point of election for the introduction of the osteotome, the

limb is flexed and placed upon a sand-bag, and a longitudinal incision is made two fingerbreadths above the internal condyle of the femur upon the inner aspect of the thigh. The osteotome is introduced down to the bone, turned at right angles to the long axis of the shaft, and with a few blows of the mallet the bone is nearly divided. After each blow the osteotome must be moved from side to side to prevent wedging, and the deeper layers of bone should be cut in a fan-like manner. When the section is nearly completed, as indicated by the depth to which the chisel has disappeared, the instrument is withdrawn and the fracture is completed with the hands. The limb is to be at once set in a slightly over-corrected position, a sterile dressing is applied, and the limb is incased in a plaster-of-Paris bandage and held in the corrected position until it hardens. The dressing need not be removed for three weeks, unless there be elevation of temperature, pain, or the dressing becomes fetid. In six weeks the patient may be permitted to stand with the casts on, or light retention braces may then be fitted.

Under full aseptic precautions the dangers attending the operation are slight.

Hemorrhage is seldom of any moment, but the anastomotica magna has been wounded and the popliteal has required ligation. Fatal hemorrhage has occurred, and amputation for gangrene has been performed by Langton.

As compared with other operations of the same character and magnitude, the number of hemorrhages has been very few. Thus, in 525 operations by Ogston's method there were thirteen severe hemorrhages, while in 580 by Macewen's operation there were only two.

These accidents occur from allowing the instrument to slip, by using too broad an osteotome, and by not cutting the posterior part of the bone with the chisel pointed forward and outward, but allowing the chisel to point back-



FIG. 557.—GRATTAN OSTEOCLAST APPLIED, SHOWING METHOD OF FRACTURING OR BENDING UPPER THIRD OF TIBIA (Blanchard).

ward. Some operators prefer to perform the operation upon the outer side, and Hahn advocates its performance on both the outer and inner side.

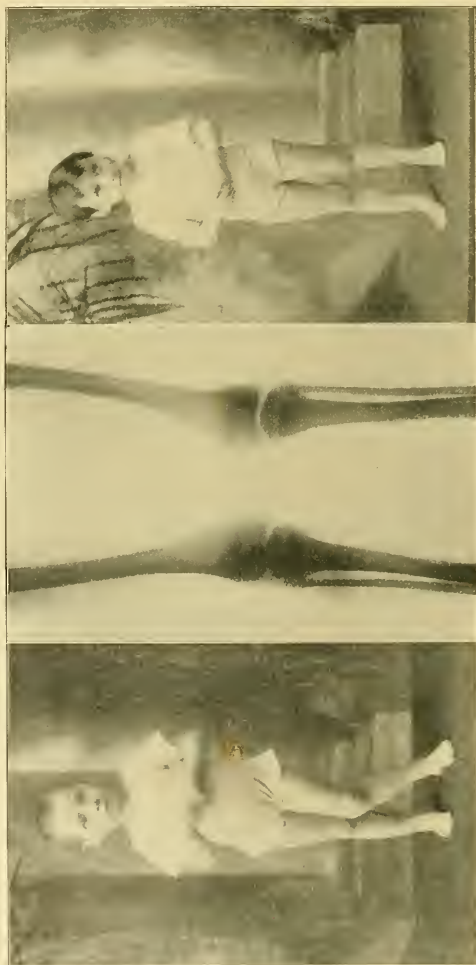


FIG. 558.

FIG. 559.

FIG. 560.

Fig. 558. A case of bilateral genu valgum with the central deformity just below the head of the left tibia. Fig. 559, Skiagram, after correction at the apex of the deformity in the tibia at letter A, showing the condyles of both legs to be practically normal. Fig. 560, The same case six weeks after correction (Blanchard).

When the deformity lies chiefly in the head of the tibia, osteotomy of this bone is a rational and necessary operation, and may be performed as follows: A transverse incision one-half inch long is made three-quarters of an inch

below the spine of the tibia, extending through the skin and periosteum. The outer compact portion of the tibia is then cut transversely and the bone fractured. Wedge-shaped sections of the tibia and femur are seldom necessary. If the fibula cannot be fractured by manual efforts, it should be divided on the same plane by a lateral incision, care being taken to avoid wounding the peroneal nerve.

4. Osteoclasia, or forcible fracture of bones by instrumental means, is said to have been practised by the fathers of medicine, and has again recently been advocated, especially by the French, for the relief of genu valgum.

The objections to the method are the splintering of the fragments, rupture of the ligaments, and separation of the epiphysis. The more recent instruments of French make are said to have overcome these objections and to be capable of breaking the femur within two fingerbreadths of the joint without affecting the articulation. By the use of the Grattan osteoclast applied in some instances below the knee-joint Blanchard has succeeded in correcting knock-knee without any accidents in a large number of patients.

Osteoclasia is more applicable to the shaft of the bone, as in the correction of bow-legs, and is slightly more safe in this locality than osteotomy, whereas osteotomy is considered superior for the correction of genu valgum.

BOW-LEGS.

Bow-legs, or genu varum, is that deformity in which the knee is thrown outside a perpendicular line drawn from the head of the femur to midway between the malleoli. It is the opposite condition to knock-knee, an adduction contracture.

Synonyms.—*English*, Bandy-legs; Barrel-leg; Saddle-leg. *German*, Säbel-bein; Sichel-bein; O-bein. *French*, Genou en Dehors. *Latin*, Genu Extrorsum. *Greek*, Exogonyancon. *Italian*, Storto di gambe; Lo Strambio. *Spanish*, Patizambo (bandy-legged); Pierna Zamba; Zamba de piernas.

Varieties.—It is generally double, but may be single, or may accompany knock-knee of the opposite side. It may be due to a gradual curvature outward of the shafts of the femur and tibia, to bowing outward of the lower third of the tibia, the femur remaining normal, or both bones may be bent forward and outward. The knee is very seldom primarily affected.

Etiology.—It occurs in children about the time of walking, and is almost without exception rachitic in origin. The chief factor in producing the

deformity is the body-weight in standing and walking. Muscular action is a factor in some children who have never walked, but it cannot be accepted as the chief cause, as has been asserted. The direction in which the bones yield to the superincumbent weight of the body will depend upon the direction in which the pressure is transmitted, the weak part of the bone normally, and the location of the rachitic softening.

In children who have not walked, the bowing of the tibia outward may be accounted for by the tailor fashion of sitting assumed by small children.

Children affected with rickets stand with the thighs flexed, the feet wide apart, and the lumbar spine arched forward, this position being assumed on account of muscular weakness, or more probably on account of the pendulous and weighty abdomen. In this position the line of gravity falls outside the knee-joint, the shafts of the long bones yield to the pressure, and in time the internal condyle atrophies and the outer one hypertrophies. In some cases the bowing is extreme and the outline of the legs is almost circular.

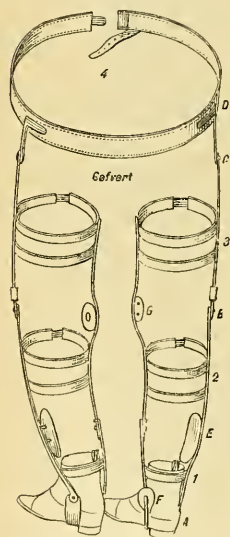


FIG. 561.—BOW-LEGS BRACE.

Symptoms.—These are principally the deformity of the legs, the diminished height, and the peculiar waddling gait in walking.

In cases where bow-legs and knock-knee coexist on opposite sides the bow-leg is always the more secure. The feet are usually inverted, in an instinctive effort to contract the base of support, and favor progression.

Diagnosis.—The condition is clear upon inspection, but it is always necessary to determine also the location and degree of bowing, and the condition of the bones.

The only affection which it resembles is congenital dislocation of the hip, and the differential diagnosis from this has already been pointed out. The presence or absence of coxa vara should also be noted, since this condition may simulate bow-legs.

Prognosis.—The prospects of spontaneous outgrowth of this deformity are more favorable than in knock-knee, but the fact that bow-legs are met with among adults proves that some cases never entirely recover. When the

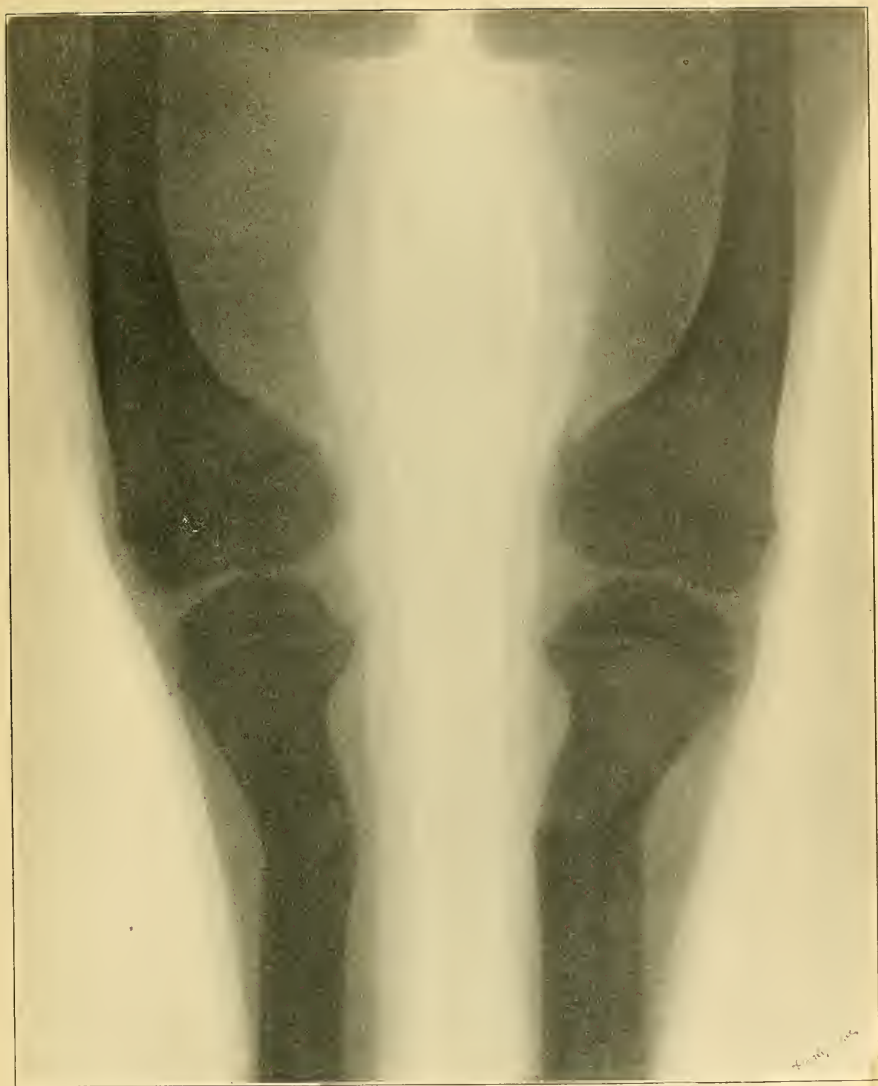


FIG. 562.—SKIAGRAPH. BOW-LEGS AFTER OSTEOTOMY. ONE OF AUTHOR'S CASES.

bones harden in this deformed position, recovery without mechanical treatment or operation is not to be expected.

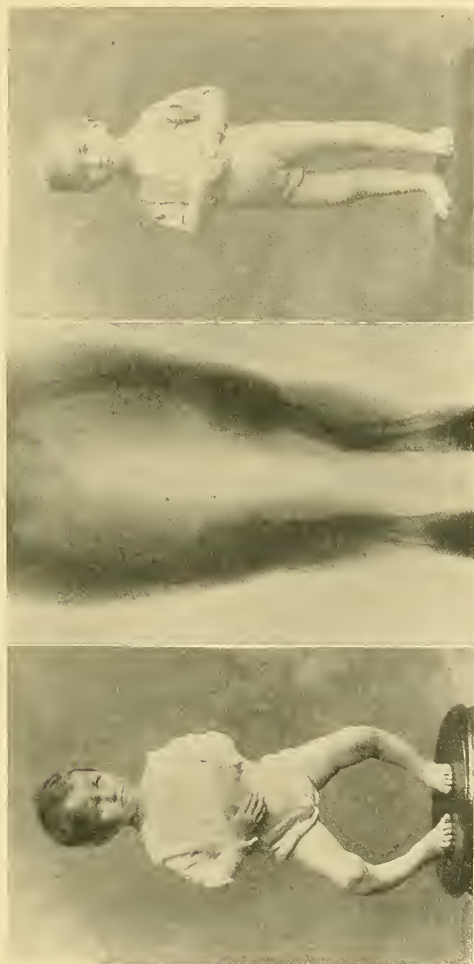


FIG. 563.

FIG. 564.

FIG. 565.

Fig. 563, A typical case of genu varum. Fig. 564, Skiagram showing over-correction of the tibia at the apex of the deformity. Fig. 565, The same case six weeks after the operation, showing that the over-correction has been assimilated into the general contour, producing symmetric legs (Blanchard).

Treatment.—The treatment of knock-knee may be included under three heads: (1) Hygienic; (2) Mechanical; and (3) Operative.

The hygienic plan of treatment includes the correction of the rachitic

diathesis by proper medication and improved hygiene, daily rubbing of the limbs, and manipulation of the deformity with the hands, grasping the limb with the hands upon the outer side and applying pressure in such a manner as gradually to reduce the deformity.

The mechanical treatment is to be conducted upon the same general principles as knock-knee. In most cases the leg-brace before described, but with the pressure-pads differently located, and with the addition of a special pressure device over the outer side of the leg, answers well as a retention and walking brace. The pads are applied to the inner ankle and inner side of the knee, and the uprights between the knee and ankle are hinged on the outer side to the oval pressure pad, while the inner upright has an adjustable slide which allows of extension as the leg is straightened. Mechanical treatment is not of service after the bones have hardened, and are useless usually after the age of three and one-half to four years. Careful tracings from time to time will indicate the progress of the case.

The operative treatment of bow-legs includes: (1) Osteotomy, and (2) Osteoclasis.

Osteotomy is the operation usually performed by American surgeons, although the results of osteoclasis are more favorable in bow-legs than in knock-knee, and the same dangers are not to be feared. Osteotomy for bow-legs is performed in a similar manner to that for knock-knee, and several sections of the bone may be required, as high as six and even ten osteotomies having been performed at one time, these sections being made wherever they appear most necessary. In many section of the upper part of the tibia will give the best results. In performing this operation great care should be exercised to avoid wounding the anterior tibial in front, and the posterior behind, and if the fibula require division on the same level the peroneal nerve is in danger. The same rules and technic should be observed as in operations for knock-knee. As a rule, in osteotomy for bow-legs, simple linear osteotomy will be all that is required, and removal of a wedge of bone will be required only in the most exceptional cases. If the fragments override, a subcutaneous section of the tendo Achillis will usually correct it.

Osteoclasis is most efficient in outward bowing of the femur and tibia, since the sharp edge of the tibia offers a disadvantage to its application in anterior bowing of the leg. It is not applicable in adults nor where the bones are very strong. The fracture with the osteoclast is a transverse one without splintering, and will usually be found to occur opposite to the screw-

pad plate. Blanchard has performed osteoclasis upward of seven hundred times for rachitic deformities without an accident. The great danger in osteoclasis is delay in releasing the machine after the fracture has been made. The pressure should only be momentary.

After correction the deformity should be slightly over-corrected.

Anterior bow-legs consists of a long gradual curve from the knee to the ankle, or an abrupt angular curve in any portion of the bone, but usually in the lower third. It is produced by sitting constantly with one leg resting upon the other, or by the weight of the body falling upon the leg with the knee bent.

The course, symptoms, and diagnosis are the same as in other rachitic curves. When severe, the bending of the tibia may be mistaken for arthritis deformans syphilitica, as both diseases may occur about the same age. The unilateral distribution of the latter affection, together with the absence of other rachitic symptoms, will serve to distinguish it. The prognosis is not so favorable as in knock-knee and bow-legs, the mechanical conditions being entirely different. The treatment may be mechanical or operative. In the early stages, before the third year, much may be accomplished by manual straightening and the use of pressure apparatus, but all orthopedic writers agree that after once the bone has hardened anterior curves of any magnitude cannot be reduced by apparatus.

The form of apparatus employed during the early stages consists of lateral steel uprights attached by a stirrup to the shoe below, secured to the leg above by a leather band, and making pressure over the curve in front by means of a broad leather strap or pad connected with the steel uprights.

The operative procedures include forcible fractures, osteoclasis, and osteotomy.

Forcible fracture in children under three years of age is safe and efficient, both bones being fractured by the hands, a roller bandage, a sand-bag, or the knee of the operator being used as a fulcrum. After correction the limb should be secured in a plaster-of-Paris dressing.

Osteoclasis offers the advantage over manual correction that pressure can be applied to a definite point, but in this locality is less subject to the objections already detailed.

Osteotomy gives uniformly excellent and speedy results. In deformities of moderate degrees simple linear osteotomy with a chisel is efficient, but in the severer grades cuneiform osteotomy, or removal of a wedge-shaped piece of bone, is necessary.

Simple linear osteotomy is performed as already described. In performing cuneiform osteotomy the most rigid asepsis must be enforced.

To determine the amount of wedge to be removed, the sphenometer may be used, or, what most surgeons prefer, a paper outline of the anterior aspect of the leg may be drawn and cut out. This, when cut through the point of curvature and straightened, will give the size of the wedge.

The fibula, if rigid and strong, should first be divided. The section in the tibia with the chisel should extend two-thirds through, and the wedge should be taken away by a series of chippings, and the bone finally fractured by manual force. This is necessary on account of the close proximity of the posterior tibial artery and vein, Dandridge having lost a patient from pyemia following an injury of these vessels.

Tenotomy of the tendo Achillis is required in almost all cases. Drainage with sterilized catgut or horsehair is necessary, and full sterile dressing and a plaster-of-Paris cast should be employed.

CHAPTER XXVI.

OTHER DEFORMING DISEASES OF THE BONES.

Tardy Hereditary Syphilis of the Bones.

The deformities resulting from hereditary syphilis were entirely overlooked until Hutchinson and Fournier called particular attention to them. Since then Hoffa has referred to syphilitic deforming osteitis of the lower extremity, and others have reported cases of tardy hereditary syphilis of the bones.

This is a disease of the bones producing at times considerable deformity and accompanied with constitutional disturbance, but which is often suffered to pass unrecognized. It cannot be a very rare affection, for in the past ten years at least twenty cases have come under my notice.

Synonyms.—*French*, Syphilis Héréditaire Tardive. *German*, Osteitis Deformans Syphilitica. *Italian*, Ostiti ereditaria sifilitica. *Spanish*, Ostitis hereditaria sifilitica.

When tardy hereditary syphilis affects the bones, it is most apt to do so between the ages of six and ten years, although cases do occur as early as two, and even in adults. In its commencement the affection is apt to be regarded as rheumatic because of the pains; these may be located either in the shaft of the bones or in the neighborhood of the articulations. They may be very severe and worse at night and after use of the limb, preventing the patient from sleeping. In some cases they vary in severity with the state of the weather. In cases in which the disease is active marked changes of temperature are observed, while, when it is chronic or subacute, it may be only slightly elevated or not at all. In very acute cases the temperature may rise very high. It only occasionally shows the marked rise and fall seen in septic diseases, and then only for a day or two at a time. Usually it resembles more that of typhoid fever, having a daily variation of from one to three degrees. Chills are not present. After the disease has existed for a variable period of time enlargement of the bones is observed. This may occur either regularly around the bone or localized more to one side. In the tibia it is usually in a forward

direction, causing it to project in a peculiar manner and forming the saber-bladed deformity of Fournier. The surface of the bone is also irregularly enlarged in the form of nodes, showing the presence of periostitis as well as osteitis.



FIG. 566.—SABER-BLADED DEFORMITY OF TIBIA FROM SYPHILIS.

When the affected bony surface is subcutaneous and the process active, the skin assumes a dusky red color, fluctuation and perforation occur, and a scale of bone is cast off. This exfoliation may consist of a few calcareous granules or of a large scale, or, if the process is exceptionally severe, may involve a considerable portion of the shaft itself. The tibia is the bone most frequently affected, but I have seen the fibula and radius also attacked. Pains have also been complained of by the patients in other parts of the skeleton, which would indicate that they too were affected. In examining into the history of these cases sometimes other manifestations of the syphilitic disease are discovered, such as imperfections of the teeth; these are not so apt to be notched as pegged and decayed. Evidences of old eye-trouble, keratitis, etc., deafness, snuffles, and eruptions in infancy, and general malnutrition may also at one time have been present. The history of the parents and brothers and sisters usually yields confirmatory facts, the infant mortality being great, and miscarriages not uncommon; hydrocephalus may also occur. The course of the disease is essentially chronic. Remissions occur only to be succeeded by a reappearance of the symptoms.

Suppuration and exfoliation of bone are followed by healing with disfiguring scars. The swellings not infrequently disappear without leaving any trace of their presence.

The disease does not tend to a fatal issue, but exists in a more or less active state for four to eight or more years. When the tibia is affected near its epiphyses, its growth is accelerated and it becomes longer than the fibula, thus throwing the foot outward in the position of the valgus; and when the radius is affected, the hand may be pushed toward the ulnar side.

As regards internal medication, iodid of potassium in as large doses as the patient will bear for long periods of time should be tried, to be alternated with mercurials, tincture of iron, syrup of the hypophosphites, syrup of the iodid of iron, cod-liver oil, and other alterative and tonic remedies. By these measures the disease may be arrested.

The tendency to valgus should be corrected by an ankle brace with a pad at the inner ankle, and a leather strap over the greatest prominence of the deformity. Any increase in the lengths of the limbs should be equalized by an elevated sole upon the shoe of the sound side.

As long as the disease is active operative treatment must be delayed. Subsequently an osteotomy, simple or cuneiform in character, should be performed, after which a brace should be worn for a time.

Osteomalacia.

Osteomalacia is an inflammatory process of the bones characterized by the absorption of the lime salts, softening, and deformity. It is also known as *mollitis ossium*. It resembles rickets, but the process begins in the medulla and extends outward, the periosteum being hypertrophied later. The affection has been observed from birth, an example of which has been illustrated in Part I. Instances occurring during childhood have been recorded, but it is most prevalent during adult life. Females suffer more frequently than males, a fact attributed to parturition. The puerperal form has its origin in the pelvis, whence it may extend to other parts.

The etiology of this disease is still in doubt. The treatment consists in supporting the deformed bones by apparatus, and where the deformity is excessive, in correcting the angular bending of the long bones by osteotomy. After operation apparatus must be worn continuously as long as the condition exists. It has been observed by the writer that greater care must be observed to maintain a corrected position for the fragments after osteotomy, and sometimes wiring is absolutely necessary, especially in the femur.

Osteitis Deformans.

Synonyms.—*English*, Paget's disease. *German*, Osteomalacia chronica deformans hypertrophica; Paget'sche Krankheit.

Since attention was first called to this disease by Paget in 1877 numerous examples have been observed, and Packard, Steel, and Kirkbride have recorded sixty-seven instances, the majority of which occurred in males.

The disease is a chronic inflammatory process affecting the bones, symmetric in distribution, and characterized by hypertrophy, softening, and deformity.

Etiology.—Nothing definite is known as to the cause or nature of this disease, but its association with arthritis deformans has led to the assertion that they are pathologically identical, while the enlargement of the skull relates it in some obscure manner with acromegaly.

Symptoms.—The affection may begin abruptly, but usually there is an incipient stage of periosteal pain, headache, etc., preceding the bone inflammation. The general constitutional symptoms are not striking. Kyphosis is present, the head is held forward with drooping of the shoulders, and there is a stiff, clumsy gait. The skull is enlarged, the long bones are hypertrophied, and the extremities are bowed at the knees. The distribution of the deformity is bilateral.

The course of the affection is slow and progressive, and there is no known treatment which will arrest the progress of the disease.

Secondary Hypertrophic Osteo-arthritis.

The deformity of the extremities which occurs secondary to chronic pulmonary affections is interesting to the orthopedic surgeon on account of the differential diagnosis.

Since the disease was first described by Marie in 1890 numerous cases have been observed. The condition is an inflammatory lesion of the osseous structures and is characterized by clubbing of the fingers and enlargement of the distal extremities of the tibia and fibula, and the metatarsal and phalangeal bones in the feet, and of the distal extremities of the radius and ulna, and metacarpal and phalangeal bones in the hands. The osseous deposit is most marked beneath the periosteum. The skull is not affected and the lesion of the extremities is largely due to the impairment in the circulation. The affection is uncommon in childhood.

This disease might be confused with acromegaly, and for this reason this latter condition deserves consideration here. In acromegaly enlargement of

the hands and feet is associated with enlargement of the face. It usually occurs among men of gigantic size. The characteristics which distinguish this affection are that the enlargement of the extremities involves all the tissues and is not confined to the bone. The enlargement does not affect the shafts of the bones, and the head is frequently involved, the enlargement including the face, and not being confined to the skull.

In secondary hypertrophic osteo-arthropathy the course of the disease is progressively worse, except in rare instances when recovery has been observed.

Arthritis Deformans.

A chronic disease of the joints characterized by great deformity following changes in the bone, cartilage, and synovial membrane, with peri-articular formation of new bone.

The existence of these affections among the ancients is attested by the evidences found by Chiase in the bones unearthed at Pompeii, in an Egyptian skeleton of the Ptolemaic period, in the Roman skeleton found in a sarcophagus at Smithfield, England, and in the skeleton of the Norse viking which was found entombed in his warship, in the Christiania Fjord.

Synonyms.—*English*, Rheumatoid Arthritis; Osteoarthritis; Arthritis Chronica Ulcerosa Sicca; Nodular Rheumatism; Chronic Articular Rheumatism; Chronic Rheumatic Arthritis; Rheumatic Gout; Dry or Proliferating Arthritis; Nodosity of the Joints; Chronic Rheumatoid Arthritis of the Hip. *French*, Rheumatisme noneax; Rheumatisme chronique primitif. *Italian*, Artriti reumatoida. *Spanish*, Artritis reumatoida.

Etiology.—The true nature of this disease is very obscure. It has been ascribed to rheumatism or gout; to exposure or traumatism; injury seems to play some part in its causation, as it is often found following fracture of the hip-joint. Recent authorities are inclined to consider arthritis deformans among the arthropathies of spinal cord origin similar to the joint lesions of syringomyelia and tabes. The nervous element is still in doubt, however, although articles have been contributed by Hektoen, Mitchell, Latham, and others in support of this view. Schüller describes a bacillus found in the joints of arthritis deformans, with which he has been able to produce, experimentally, similar processes in the joints of animals. Dor produced similar changes in the joints of animals by the injection of attenuated cultures of staphylococcus. Two forms of the disease are recognized: (1) Osteoarthritis, a polyarticular

form occurring in advanced life, in which marked hypertrophic changes are present in the articular surfaces, consisting of bony formations, primarily involving the articulation and leading to marked enlargement of the

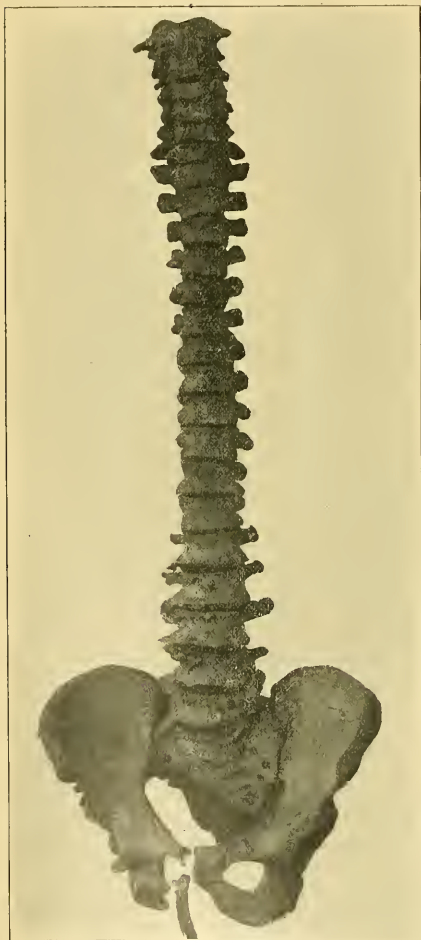


FIG. 567.—RHEUMATOID ARTHRITIS (Specimen, Wistar Institute of Anatomy).



FIG. 568.—RHIZOMELIC SPONDYLITIS.

joint, distortion, and ankylosis; and (2) rheumatoid arthritis, a polyarticular form occurring in childhood or early adult life, in which there is primary disease of

the soft parts of the joint, and is not followed by marked bony enlargement but frequently results in true ankylosis. Another form has been described by Marie as rhizomelic spondylosis, from its derivation—relating or affecting the roots of members—in which ankylosis of the vertebrae is associated with ankylosis of the hips and shoulders. The affection does not otherwise differ from the adult variety.

Pathology.—The pathologic changes in the hypertrophic form begin with thickening of the synovial membrane, with hypertrophy



FIG. 569.—RHEUMATOID ARTHRITIS OF KNEE.

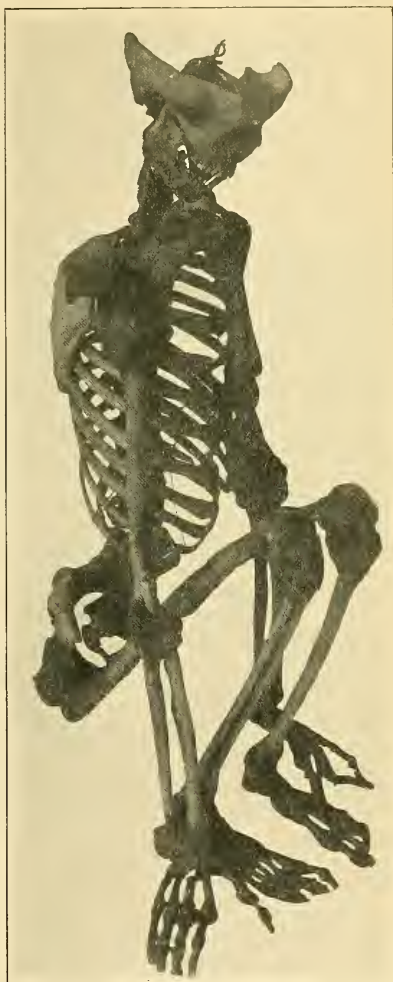


FIG. 570.—FALSE ANKYLOSIS FROM CHRONIC RHEUMATOID ARTHRITIS.

of its fringes, the branching appearance of which has given rise to the name of lipoma arborescens.

The cartilage disintegrates, presenting a yellow shreddy appearance, and finally is absorbed or gradually thinned by attrition, thus laying bare the ends of the bone, which become smooth, polished, and eburnated. The head of the bone may be locked in a splint of osteophytes which form from the proliferated cells; or, denuded of its cartilage, may undergo an ivory-like condensation (eburnated layer) with final atrophy, exposing the Haversian canals and presenting a worm-eaten appearance. The muscles around the joint become wasted, the lig-



FIG. 571.—RHEUMATOID ARTHRITIS. SPECIMEN.



FIG. 572.—RHEUMATOID ARTHRITIS. SPECIMEN.

aments greatly thickened, which, together with the osteophytes, often form a false ankylosis of the joint.

The form found in childhood and early adult life is characterized by marked inflammatory changes beginning in the synovial membrane and soft parts, with resulting hypertrophy of the synovial villi and effusion. The cartilages become eroded, but are not destroyed, and the erosion is not followed by hypertrophy of the ends of the bones. Later atrophy of the synovial membrane

occurs, accompanied by the formation of fibrous tissue and resulting ankylosis. Schüller describes the two forms under the terms *polyarthritis villosa hyperplastica* and *polyarthritis villosa ankylopoetica*.

Symptoms.—In its acute form this disease resembles articular rheumatism. If, as is more usual, it begins in its chronic form, the first symptom is pain on motion, stiffness and swelling of the joint. From involvement of one joint the disease may spread until nearly all of the articulations of the body are affected. The amount of pain and of the effusion into the joint varies greatly. The shape of the joint is permanently altered by the deposition of new



FIG. 573.—OSTEO-ARTHRITIS OF THE KNEE-JOINT.



FIG. 574.—CHRONIC RHEUMATOID ARTHRITIS IN CHILD.

bone, by the thickening of ligaments, and atrophy and retraction of the muscles. A peculiar crepitation produced by the friction of roughened synovial membrane is recognizable. Motion may be entirely lost, either from muscular spasm or from the splint of osteophytes.

In the femur, from atrophy of the neck, the trochanter may be found above Nélaton's line. Heberden's nodosities is a variety of this disease in which little nodules develop upon the sides of the distal phalanges.

In childhood, in addition to the periarticular changes already noted, there are associated extreme muscular atrophy, lymphatic enlargements of the axillary and inguinal glands, with hypertrophy of the spleen and liver. Deformity is great and ankylosis often results. The disease is sometimes spoken of as Still's disease, from its discoverer.

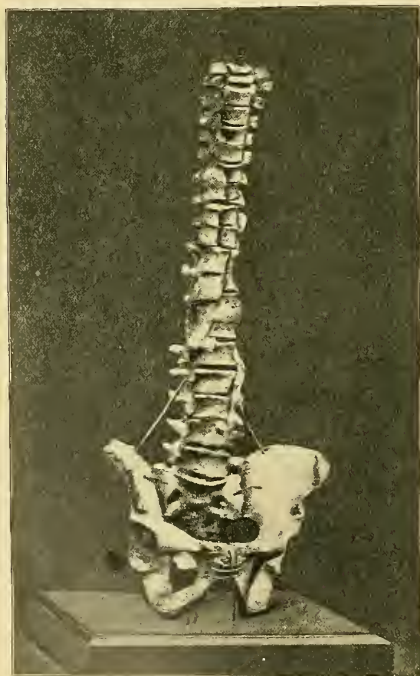


FIG. 575.—PHOTOGRAPH OF SPECIMEN OF SPONDYLITIS DEFORMANS, SHOWING DEPOSITS (from the Museum of the Philadelphia Hospital).



FIG. 576.—CHRONIC RHEUMATOID ARTHRITIS, WITH LATERAL CURVATURE AND ENLARGEMENT OF THE ACETABULA AND HEADS OF FEMUR.

Spondylitis Deformans, or Rheumatism of the Spine.

A primary ankylosing arthritis of the vertebral column is a complication of arthritis deformans as it occasionally is of gonorrheal rheumatism. It presents,

as its characteristic symptom, marked stiffness of the spine; indeed, the whole vertebral column may be as rigid as an iron rod. Paroxysmal pain aggravated by every jar is present. The normal curves are exaggerated, especially the lumbar and dorsal ones, so that the patient may walk as though bent with Pott's disease. The cervical vertebrae are the last to become involved. In that case the up-and-down movements of the head are lost, though rotation is still possible. In severe cases the ankylosis of the ribs with the spine is so complete that chest expansion is almost abolished, the breathing being entirely abdominal. Its course is chronic in the extreme; the bone inflammation, having no destructive tendency, accomplishes nothing more than stiffening of the column.

Diagnosis.—The diagnosis in the senile or hypertrophic form depends upon the age, the polyarticular involvement, the slowly increasing deformity, the marked increase in size of the affected joints, the presence of the *ecchondroses* and *Heberden's nodosities*.

In the juvenile or atrophic form the history of injury, the polyarticular involvement, the marked deformities and resulting ankylosis will aid in making a diagnosis. Its course is rather rapid, the process of deformity developing in one or two years after the injury, accompanied by pain and impairment of motion, until walking is difficult and finally ankylosis occurs.

Treatment.—The pain and irritation of the acute attack are relieved by rest in bed, with more perfect rest of the joint by the use of a traction splint. Counter-irritation by means of the Paquelin cautery, blisters, or iodine is of value in meeting this indication, as is the use of hot or cold douching. In *spondylitis deformans* a posterior spinal splint is of service, and when the cervical vertebrae are involved an antero-posterior head support with a chin-rest.

The disease is an incurable one, but its progress may be arrested by a visit to some of the numerous foreign or domestic mineral springs: Carlsbad, Baden, or Vichy; Buxton, Harrogate, or Bath in England, or Richfield, Sharon, or Arkansas Hot Springs in our own country. Water from the Veronica spring in California is highly recommended. The general health must be maintained by tonics, good food, and fresh air. The diet should be carefully regulated and fatigue and over-exertion prevented. Internal remedies, as salicylic acid, arsenic, potassium iodide, salophen, and cod-liver oil produce no appreciable change in the condition. Massage may help to promote the absorption of the effusion and to restore mobility and maintain the nutrition of the muscles, but passive movements are to be avoided, as increasing the amount and degree of ankylosis.

In senile coxitis a protection traction hip-splint will be of service, and crutches and canes are often useful.

In the late stages of ankylosis with deformity some good can be effected by surgical means. König, Poppert, Müller, Collison, and Bloodgood report good results following resection of various joints which were ankylosed in a deformed position. While the disease is not cured or even arrested in this way, yet such good functional results follow, and the condition is temporarily improved to such an extent, that no hesitancy should be felt about performing resection. In the treatment of arthritis deformans in children and young adults, good results follow the use of appropriate apparatus to prevent further and to correct existing deformities. Local measures—as ointments of ichthyol, iodine, and mercury, hot air, massage, and electricity—exert a favorable influence upon the course of the disease. Apparatus limiting motion within the painless area should be used. When ankylosis with deformity has taken place, it may be forcibly overcome, if fibrous, under anesthesia, by means of forcibly breaking up the adhesions and performing necessary tenotomies; or if bony, by means of osteotomy or resection.

CHAPTER XXVII.

TALIPES, OR CLUB-FOOT.

The generic term talipes, or club-foot, as suggested by Little, signifies an abnormal position of the foot, whether in antero-posterior or transverse plane, in its anatomic relations to the leg, or of the foot to itself.

This abnormal position may consist of a flexion, extension, inversion, or eversion, or combinations of these, but is popularly applied to that deformity in which the foot is twisted inward so that the weight of the body is borne upon the outer side or dorsum of the foot.

Synonyms.—*English*, Reel-foot; Stump-foot. *Latin*, Pes Contortus. *Greek*, Kyllosis. *French*, Pied-bot. *German*, Klumpfuss. *Italian*, Piede torto; Stortodel piede. *Spanish*, Pié Truncado.

Anatomy of the Foot.

It may be instructive here to review briefly the anatomic construction and mechanism of the natural foot. The foot includes all that portion of the inferior extremity below the tibiotarsal articulation, consisting of the tarsus, metatarsus, and phalanges, and in the adult has the form of two arches, an antero-posterior and a transverse, each with its convexity or dorsal surface above, and its concavity or plantar surface below.

The antero-posterior arch, the most important, is supported upon two piers or pillars, and has its summit at the astragalus and ankle-joint. This has been still further divided into two arches, an outer and an inner, by an imaginary line drawn posteriorly between the third and fourth metatarsal bones. The inner portion of the antero-posterior arch is much more curved than the outer, and forms the instep.

The posterior pier, formed by the posterior parts of the astragalus and os calcis, is shorter, more curved, has but one joint, and is more solid, receiving the greater part of the weight of the body. The anterior pier, composed of the scaphoid, three cuneiform, and three inner metatarsal bones, is longer, less curved, has many joints, and is more elastic, serving to diminish the force of shocks transmitted to the arch. The head of the astragalus, fitting into the

concave surface of the scaphoid, and its postero-inferior surface, articulating with the anterior surface of the os calcis, may be regarded as the keystone, though differing in many respects from such bodies as usually employed. The weak part of the arch is strengthened by the interosseous ligaments, particularly the inferior calcaneo-scaphoid, which supports it from below, while beneath, the inner portion of the plantar fascia adds additional strength. The outer portion of the antero-posterior arch consists of the outer portion of the os calcis, cuboid, and the two outer metatarsal bones. It is strengthened by the calcaneo-cuboid ligaments and the outer portion of the plantar fascia. Both arches are still further maintained by the tibialis posticus and peronei muscles, particularly the peroneus longus. The transverse arch, formed on the inner and outer sides by the bones entering into the inner and outer antero-posterior arches respectively, varies in degree of curvature in different portions of the foot, being most marked across the cuneiform bones. It affords protection to the soft parts of the sole, and adds to the elasticity.

To appreciate more thoroughly the deformities under consideration, the foot is best divided anatomically into an anterior portion, the "pes" or foot proper, and the posterior portion, the "talus" or ankle. These articulate at the *medio-tarsal* or Chopart's joint, formed between the os calcis and astragalus behind, and the cuboid and scaphoid in front, a joint which admits in a limited degree of every variety of movement—flexion, extension, abduction, adduction, and rotation.

The amount of lateral deviation of which the normal foot is capable is well shown by obtaining outline tracings of the foot, using one of the methods previously described. Upon this outline the mid-tarsal joint is marked by a straight line drawn from a point just posterior to the tuberosity of the scaphoid on the inner side to a point midway between the base of the fifth metatarsal and the tip of the external malleolus on the outer side. To obtain a correct basis of measurement, the mid-tarsal joint is taken as a base-line, erecting upon it a perpendicular corresponding to the long axis of the os calcis. Another line is drawn from the intersection of these two lines through the ball of the great toe. The angle formed by this last line and the perpendicular line is the angle of deflection of the foot. In this manner the angle of deflection was found to range between 26 and 37 degrees (*average*, 20 males, 34.8 degrees; 12 females, 31.5 degrees), typical examples of which are seen in the accompanying figures (Figs. 578 to 581).

The tibio-tarsal or ankle-joint admits of flexion and extension, and,

according to Gray, in extreme extension of a slight amount of adduction also. This is in consequence of the articular surface of the astragalus being wider in front than behind, so that in complete extension the narrowest part of the astragalus is lodged in the widest part of the tibio-fibular arch, admitting of lateral motion. In the flexed position, however, *no lateral motion is possible*.

The normal amount of flexion and extension of the foot is as follows: Extension in the adult is limited at about 135 degrees, or 45 degrees more than a right angle, using the long axis of the tibia as the plane of measurement. Flexion stops at about 70 degrees, or 20 degrees less than a right angle. The position of the foot in standing upon an even surface, with the knee in full extension, is about 90 degrees. The amount of flexion and extension varies in different individuals, but these figures, based upon actual experiment and measurement, represent the average of normal movement in the living adult subject.

In the normal condition of the foot these movements are accomplished, and a correct anatomic relation of the parts is preserved, by the muscles of the leg, which may be conveniently divided into four groups, moving the foot in four directions.

Thus, the anterior group of muscles—the tibialis anticus, extensor longus digitorum, and peroneus tertius—act upon the foot as flexors; the superficial set of the posterior group—the gastrocnemius, soleus, and plantaris, assisted by the peroneus longus—act as extensors; the deep set of the posterior group—the flexor longus digitorum and tibialis posticus, assisted by the tibialis anticus—act as adductors; and the external or fibular group, the three peronei (longus, brevis, and tertius) act as abductors.

The weight of the body is received by the astragalus, the highest part of the arch, and transmitted to the ground through the two piers of the antero-posterior arches. The foot in extension rests normally upon the heel, the tips of the metatarsal bones, and the outer side of the sole, the weight of the body in standing, walking, running, or dancing being transmitted through the heel.

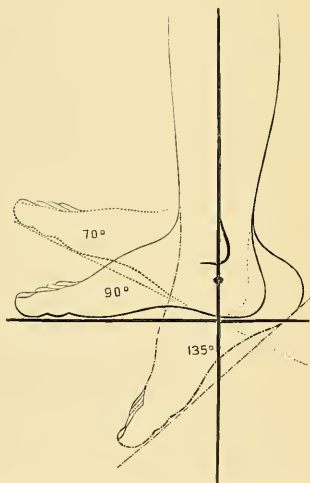


FIG. 577.—DIAGRAM ILLUSTRATING RANGE OF MOTION IN NORMAL FOOT.

the ball of the great toe, and that of the little toe—the natural tripod of the foot—in the order named.

Thus the direction of the weight upon the arches is constantly changing, and it is only through the action of these muscles that the normal arches are

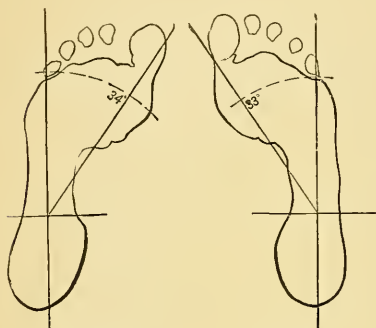


FIG. 578.

FIG. 579.

FIGS. 578, 579.—ANGLE OF DEFLECTION, NORMAL MALE FEET (Roberts).

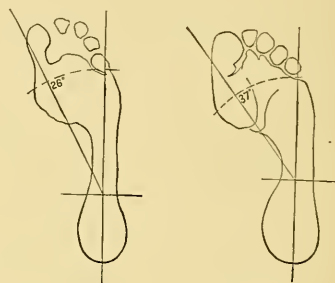


FIG. 580.

FIG. 581.

FIGS. 580, 581.—ANGLE OF DEFLECTION, NORMAL FEMALE FEET (Roberts).

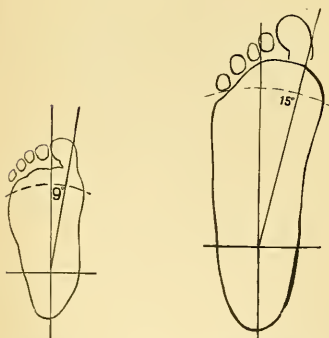


FIG. 582.

FIG. 583.

FIGS. 582, 583.—ANGLE OF INTERNAL DEFLECTION IN VALGUS (Roberts).

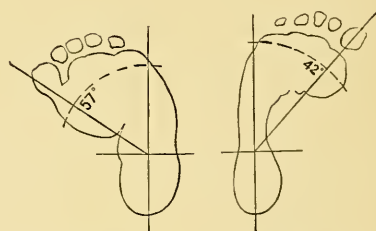


FIG. 584.

FIG. 585.

FIGS. 584, 585.—ANGLE OF ADDUCTION OF VARUS (Roberts).

preserved. Thus in flexion the antero-posterior arch is increased by the action of the *tibialis anticus*, *peroneus tertius*, and *extensor longus digitorum*; and in extension, by the action of the *gastrocnemius*, *soleus*, *plantaris*, and *peroneus longus*, both the curves are diminished, and the foot flattened. Then,

also, when the foot is markedly flexed the foot is adducted, and when markedly extended it is abducted, in which positions the arches are respectively increased and diminished. It is important to remember that the attachment of the various muscles to the foot has an important influence in maintaining the plantar arches, and that the integrity of these arches depends upon the evenly balanced action of the antagonistic muscles. Thus, the tibial and peronei muscles are antagonistic, yet their combined action is an important factor in the maintenance of both the transverse and anteroposterior arches.

If the equilibrium be disturbed, the action of a single group will produce one of the simple varieties of the deformity, or, two groups acting together, one of the compound varieties. This is well exhibited in the following table:

Extension (equinus), ...	{	Gastrocnemius. Soleus. Plantaris. Peroneus longus.
Flexion (calcanus), ...	{	Tibialis anticus. Peroneus tertius. Extensor longus digitorum.
Adduction (varus), ...	{	Tibialis anticus. Tibialis posticus. Flexor longus digitorum.
Abduction (valgus), ...	{	Peroneus longus. Peroneus brevis. Peroneus tertius.

Varieties.

Systematic writers usually classify varieties of club-foot under congenital and acquired, but they are most conveniently divided into two classes, the simple and compound. Of the former there are four varieties, two on a lateral plane, talipes varus and talipes valgus, and two on the antero-posterior plane, talipes equinus and talipes calcaneus.

1. In talipes varus the inner side of the foot is raised, the sole turned inward, and the anterior portion adducted.

2. In talipes valgus, its opposite, the outer side of the foot is elevated, and the sole everted.

3. In talipes equinus the heel is elevated, the foot extended, and the patient walks on the balls of the toes.

4. In talipes calcaneus the toes are raised, the foot flexed, and the patient walks on the heel.

To these simple forms some authors have added others, and three additional simple varieties are now recognized, talipes cavus, talipes planus, and non-deforming club-foot. In talipes cavus the arch of the foot is increased; in talipes planus, its opposite, the arch is diminished and the sole rests on the ground; and in the non-deforming club-foot of Shaffer—an incomplete equinus—there is little or no deformity, but normal flexion is limited and mobility modified. Combinations of these simple forms will present the compound varieties, as equino-varus, equino-valgus, calcaneo-varus, calcaneo-valgus, etc. These may be conveniently arranged as follows:

Simple, ...	{	Lateral, ...	{	varus.
			{	valgus.
	{	Antero-posterior, ...	{	equinus.
			{	calcaneus.
Compound, ...	{	Equino-, ...	{	varus.
			{	valgus.
	{	Calcaneo-, ...	{	varus.
			{	valgus.
Other forms, ...	{	Cavus.		
		Planus.		
		Non-Deforming (Shaffer).		
	{	Neuromimesis.		

Relative Frequency.—In estimating the relative frequency of the different varieties some difficulty is experienced, owing chiefly to the different nomenclature employed by those collecting statistics. Allowing for these discrepancies, there are numerous statistics from which we may estimate the relative frequency of these affections.

Tamplin tabulated 6754 cases of club-foot, of which 1780 were congenital and 4974 acquired, by which it is shown that the greater number were of the acquired variety, the proportion being about as 3 to 1.

The relative frequency of the congenital and acquired forms is also well shown in the 746 cases recorded by Roberts from records of the New York Orthopedic Hospital and the Orthopedic Dispensary of the University of Pennsylvania, of which 213 were congenital and 533 acquired. They were as follows:

	Congenital.	Acquired.
Equinus,.....	5	87
Calcaneus,.....	3	31
Varus,.....	73	66
Valgus,.....	29	236
Equino-varus,.....	95	68
Equino-valgus,.....	3	9
Calcaneo-varus,.....	0	2
Calcaneo-valgus,.....	5	34
Totals,.....	213	533

Duval has recorded 1000 cases of club-foot, of which 574 were congenital, and of these 364 were in males, 210 in females. Though including a greater number of congenital cases, these figures are interesting as exhibiting the relative frequency of the varieties and greater liability of the male sex.

	Cases.	Boys.	Girls.
Equinus and equino-varus,.....	417	215	202
Varus,.....	532	302	230
Valgus,.....	22	14	8
Calcaneus,.....	9	6	3
Extreme calcaneus,.....	20	13	7
Totals,.....	1000	550	450

The primitive congenital equinus is exceedingly rare.

Chaussier, out of 23,923 newly born infants, found 132 affected with various deformities, 37 of them having club-foot; and Lannelongue, out of 15,229 births at the Paris Maternity Hospital, covering a period of ten years, from 1858 to 1867, collected 108 deformed infants, of which 8 had club-foot, or a proportion of 1 case in 1903 births.

K. Roser found among 100 deformed fetuses 36 with club-foot, of which 8 were double talipes varus, 11 double calcaneus, 9 calcaneovarus, and 9 with unilateral club-foot.

These statistics taken together are sufficient to show the frequent association of club-foot with other deformity; its greater frequency on the right side, and in the male; the relative greater frequency of double club-foot; the preponderance of equino-varus as a congenital variety, and the variety of primitive forms.

Etiology.

The etiology of talipes may be divided into two great classes—the congenital and the acquired.

The Etiology of Congenital Club-foot.—The study of the cause of congenital club-foot involves much that is mysterious and unexplained, from the fact that there is no direct scientific means of investigation except such data as embryologic research, comparative physiology, and post-natal life and disease furnish. Hence there is much that is purely speculative, and numerous views have been advanced and defended from time to time. These may be considered under the following heads:

1. Theory of heredity.
2. Theory of mechanical pressure, or intrauterine pressure theory.
3. Theory of pre-natal disease, or musculo-nervous theory.
4. Theory of arrest of development, or osseous theory.
5. Theory of retarded rotation or non-rotation of extremities.

Maternal impressions. In exceptional instances the striking resemblance of deformity to some object seen by the mother during her pregnancy has led the laity to consider maternal impressions as in some occult manner producing these deformities. Upon closer investigation, however, the fright or observation is found to correspond to a period of gestation when it could have had no influence upon the production of the deformity. They can be readily accounted for under existing physical causes, or are simply striking coincidences. Dabney, in ninety collected cases of maternal impressions apparently producing deformity, did not find a single case; and, according to a recent authority, there is no recorded case of the development of club-foot produced by maternal impression.

1. **Heredity**, exerting its influence through one or both parents, is undoubtedly a factor in the etiology of these cases. Particularly is this true of consanguineous marriages, which are so productive of deformities generally.

Devay and Boudin report 1 case in 164 births from marriages of kin, against 1 case in 1903 of other marriages. Reeves and Brodhurst have known several striking illustrations, in which some form of club-foot, and generally equinovarus, ran through various members of the same family. Adams gives a very interesting history of a club-footed family. The writer has recently operated upon a child whose father, in his infancy, was operated upon in Russia, by Pirogoff, for a similar deformity.

2. **The theory of mechanical or intrauterine pressure** on the fetus,

through deficient liquor amnii compression of the uterus by another part of the fetus, or the abnormal position and action of the umbilical cord, or of amniotic bands, is as old as Hippocrates. Ambroise Paré supported it, and ascribed club-foot to the circumstance that "the mother, during her pregnancy, had been sitting too much with her legs crossed." Cruveilhier supported the pressure view, but added traumatism as an elementary factor. Malgaigne, Volkmann, Kocher, Parker, Vogt, and others supported this mechanical theory of pressure and malposition *in utero*. The fact is well established that club-foot may occur through the interlocking of the feet of the fetus, and their compression or retention in this position. Against this theory many objections have been raised. If uterine pressure were an influential factor, other organs would exhibit pressure evidences, and club-hands, legs, and thighs would be common, instead of the rarest of deformities. Then, again, no appreciable difference is observed in the quantity of liquor amnii over previous births of healthy children, and Duval has asserted the reverse. Furthermore, the deformity is observed before the fourth or fifth month of intrauterine life, when the amniotic fluid is abundant and no pressure is possible. Cases of twin births have been recorded, notably one of Roberts and Ketch, of "double equino-varus in a twin, the other child showing no deformity whatsoever."

3. **The musculo-nervous theory**, the alteration of the muscles, with or without a central nervous lesion, has been supported by a galaxy of celebrities. Morgagni, Benjamin Bell, Duverney, Rudolphe, Bécлар, Jules Guérin, and Delpsch, have all given it the weight of their indorsement, the last-named being among the first to consider the influence of the malformation of the tarsal bones.

The majority of these considered a contraction of certain muscles the cause of the deformity; Rudolphe ascribed this contraction to intrauterine convulsions, Chance and Little also inclining to this view, while Bécлар and Barwell attributed it to weakness or paralysis of other muscles. Guérin believed this convulsive muscular retraction to be secondary and consecutive to a central nervous lesion, in some cases demonstrable, in others not. The microscope has not revealed changes in the fetal brain or cord, nor do the electric reactions correspond to those met in acquired cases. Chaussier, in 37 cases of club-foot, and Duval, in 574 cases of the same, found no other deformity associated. The frequent association of club-foot with spina bifida, hydrocephalus, and anencephalus, is confirmatory of this association; contrariwise, many fetuses are met having extensive nervous lesions but devoid of club-foot. Thus, Lannelongue found only four fetuses with club-foot among the 32 cases of spina bifida and encephalocele.

4. **The osseous theory**, or theory of arrest of development, the permanence of the feet in the physiologic position of the sixth or seventh fetal week, with the sole turned inward, has been maintained by Geoffroy Saint-Hilaire, Meckel, Breschet, Adams, Hueter, Eschricht, and others. This anatomic fact has been denied by Cruveilhier, but has received the support of Martin and others. While the coexistence of club-foot with such deformities as spina bifida, hare-lip, and cleft palate would seem to be confirmatory of this theory of arrest of development, yet, in such cases, the feet themselves exhibit no arrest of development, but only such changes as occur in cases unassociated with other deformity.

A modification of this theory of arrest of development, ascribing the cause to primary changes in the tarsal bones, principally the astragalus and os calcis, has been supported by Scarpa, Broca, Bouvier, Brocher, Robin, Lannelongue, Thorens, and others.

These osseous changes are by no means constant, and much difference of opinion exists as to whether they are primary and causative, or secondary, as the result of pressure.

5. **The theory of non-rotation or retarded rotation** was proposed by Berg, of New York ("Archives of Medicine," New York, December 1, 1882), announced independently by Parker and Shattuck ("British Medical Journal," 1886, vol. ii, p. 10), confirmed by Scudder ("Boylston Prize Essay," "Boston Medical and Surgical Journal," October 27, 1887), and favored by Roberts and Ketch, Bradford and Lovett, the writer, and others.

Berg, from a series of embryologic investigations, studied the changes in the position of the lower extremities at different periods of fetal life. From the flexed and crossed position of the lower extremities, all the intrauterine pressure was brought to bear directly upon the outer side of the thigh and leg corresponding to the fibular border of the leg and upon the dorsum of the foot, resulting in the foot being placed in a position of equino-varus, which he believes to be a stage in the normal development of every healthy fetus. To provide against the permanence of this, Nature provides an inward rotation of the extremity, carrying the leg away from its position against the abdomen of the fetus, bringing the soles of the feet against the uterine walls in extreme flexion, and the force of the intrauterine pressure directly upon them.

Bessel-Hagen states that the torsion of the foot varies in individuals, and also that at no time does the foot normally assume the clubbed position. He says that in an embryo 30 mm. in length the foot is normally in extreme plantar flexion, and that in an embryo 90 to 100 mm. long the foot is at right angles to the

leg, and from this time may be adducted, abducted, or dorsi-flexed. Supination near term is the more common attitude and is usually combined with dorsi-flexion. Furthermore, the leg, if the rotation were the cause, would in talipes varus be rotated outward, whereas, in fact, the rotation is usually inward. However, although Eschricht's and Berg's theory be refuted, it would seem that, according to Bessel-Hagen and Scudder, there is undoubtedly a change in attitude of the legs and feet during gestation, which more or less closely follows a fixed rule. Therefore if from any mechanical cause they become "caught" in any of these positions, a deformity will result.

In conclusion, while the subject of etiology of club-foot is still unsettled, these investigations seem to point to a failure of rotation or to non-rotation as a demonstrable theory, and one which is eminently scientific and feasible; but it would seem most reasonable that mechanical fixation of an abnormal position of the foot is responsible for the majority of the congenital forms.

Etiology of Acquired Forms.—As before pointed out in speaking of relative frequency, by far the greater number of cases are of the acquired variety, and the majority of these are paralytic.

Those which are not paralytic are usually mechanical in origin. Thus an equinus may result from the pressure of the bedclothes in long-continued decubitus, as in continued fevers, as in a case recorded by Volkmann following typhoid. Osteitis of the tarsus, ankle-joint, or the lower end of the tibia not involving the ankle-joint, as in a case of equinus in a young woman seen by the author, are frequent causes of acquired talipes. In addition to equinus, varus and valgus positions may also be produced.

Occupations necessitating long-continued standing, as cooks, bakers, printers, and other trades, frequently give rise to inflammatory forms of the affection, especially valgus.

A somewhat peculiar form of valgus—valgus adolescentium—is met about puberty, depending upon rapid growth and increase of weight without a corresponding increase of strength in the plantar arch.

Rachitic changes, particularly knock-knee, occurring about the seventh year, are another cause of acquired club-foot of the valgus variety.

Injuries, particularly Pott's fracture, luxations of the ankle-joint, burns, and extensive cicatrices about the foot or ankle-joint, are causes of the acquired varieties.

That deformities of the feet may depend upon the neurotic diathesis, as pointed out by Shaffer, is now admitted, but that they may result from reflex

paralysis, as a muscular spasm from functional disturbance of the nervous system, has been doubted by many authorities. Of the former—the neuro-mimeses of club-foot—numerous interesting cases have been recorded, notably those by Weir Mitchell, Little, Paget, Skey, and others.

A few cases of acquired club-foot have been recorded from pseudo-hypertrophic paralysis, post-hemiplegic contractions, a large number resulting from tetanoid paraplegia, but by far the greater number occur from infantile paralysis or poliomyelitis anterior. These latter will be considered in detail in their appropriate places, but it may here be stated that the talipes resulting from the tetanoid paraplegia is of the equinus variety, and that resulting from infantile paralysis is usually of the calcaneus and valgus varieties.

In these paralytic forms, as pointed out by Volkmann, the club-foot does not result from tonic contraction, but faulty positions of the feet assumed to better support the body become permanent deformities through growth of the limb.

There is also a temporary form of equinus, spastic in nature, accompanying the paraplegia of Pott's disease.

Symptoms.

In addition to the unsightly appearance, club-foot necessitates a peculiar and characteristic method of progression, depending upon the variety of the affection. Thus, in double equino-varus the feet are lifted over one another, in valgus the foot is swung outward and forward, flail-like, as each step is taken, in equinus the locomotion partakes of a springing gait, etc. In severe cases, bursæ, callosities, and severe inflammation and ulceration result from pressure upon unprotected parts, which diminishes the activity and capabilities of the patient, necessitating sitting occupations, and at times becoming so aggravated as to demand amputation. Those afflicted, likewise, are liable to become a burden to the State through their inability to earn a living.

Aside from the physical discomfort and suffering, club-foot when severe is a source of great psychic suffering. Thus Talleyrand is said to have entered the Church, and Lord Byron is said to have suffered greatly, on account of deformities of this kind.

Diagnosis.

Little difficulty is experienced in recognizing club-foot or in differentiating its individual varieties. In estimating the degree of the deformity, due attention must be given to the range of mobility of the foot as given under its normal

anatomy; and in establishing the severity of the apparent distortion, due attention should be paid to the age of the individual or length of time the affection has existed, the extent to which it can be corrected by manual means, and the existence of spasm or paralysis. Authors have attempted to divide the congenital equino-varus into three stages, according to the degree of severity, but these divisions being more arbitrary than real, have but little practical value, and a division into (1) infantile, (2) neglected, and (3) relapsed, would probably be of more service. The acquired forms, however, particularly pes valgus acquisitus, admit of such a division—the division into three forms, (1) slight, (2) medium, and (3) severe, being the one preferred.

Prognosis.

These deformities do not correct themselves, but if uncorrected grow progressively worse, but two cases of spontaneous recovery from congenital club-foot ever having been recorded. The prognosis, therefore, will depend entirely upon the form of treatment employed. Under the older mechanical methods failure in severe cases was frequently the result even after prolonged treatment. Under present methods there is a certainty of curing club-foot never before obtained, and no branch of surgery meets with greater success than does the surgical treatment of club-foot. The time required to accomplish a cure varies with the method adopted, from a few weeks to two or three months, and this will depend upon the merits of the individual case. If the cases have been slightly over-corrected,—and this should be the rule,—relapses will be rare occurrences. To avoid this, however, retentive or walking apparatus will be required, particularly in the younger cases.

In severe neglected or relapsed cases where extensive bone-cutting operations are necessary extensive sloughing sometimes occurs, and deaths have been recorded. In 160 cases collected by Lorenz there were four deaths. In 400 cases collected by M'Kenzie, of Toronto, there was no death, and no amputation.* I have had the most severe shock follow double excision of the astragalus, but have had no death.

The author has met with congenital cases in adults who refused treatment because they considered the deformity a dispensation of Providence, and dared not incur divine displeasure by permitting its cure. Such cases must remain deformed. The mental effect upon the individual after a correction is often

* "Am. Jour. Orth. Surg.," Jan., 1905, p. 288.

marked, and frequently patients are enabled to pursue occupations and responsibilities from which they were previously debarred. According to Dieffenbach, of all the women treated by him, only one was married, indicating the asceticism of humanity in matrimonial affairs, and the impediment these deformities constitute to marriage; and the writer is also acquainted with one instance where a female, beautiful in every other respect, contracted a matrimonial alliance notwithstanding the presence of this horrible deformity.

Treatment.

The successful treatment of club-foot varies according to the variety, age of patient, duration, and nature of the deformity; but it demands in most cases a combination of operative, mechanical, and orthopedic treatment. The



FIG. 586.—MANUAL CORRECTION OF CLUB-FOOT (Hoffa).

orthopedic and mechanical means include manipulations, massage and electricity, and the application of splints. The operative means include tenotomy, division of ligaments, myotomy, tarsotomy and tarsectomy, *brisement forcé*, multiple tenotomy and open incision, and amputation. All these measures aim to over-correct the deformity slightly, and to retain it in this position until the tendency to return has been overcome.

Manipulations, preferably by the hand, are as old as Hippocrates, and have from his time till the present been successfully employed

in the correction of many congenital cases. In fact, in all mild congenital cases an attempt should be made to correct the deformity by manipulations before resorting to more severe measures. In the compound varieties—for example, equino-varus—the correction should be divided into two stages: first, the eversion of the anterior portion of the foot; second, the flexion of the foot upon the leg. The foot must be firmly grasped with one hand while the other gently but firmly forces the foot into the correct position. This should be daily performed, and in the intervals the feet should be retained in their improved position. These manipulations must not be omitted until the foot is forced into an over-corrected position or the manipulations are abandoned for some method more radical. These forcible methods may also be employed under an anesthetic, and in this manner it is often astonishing how much can be accomplished by manual measures alone.

Massage and **electricity** are particularly useful in the paralytic varieties, but they are almost as important in congenital cases as a part of the after-treatment; indeed, the writer is inclined to look upon the after-treatment of tenotomy, which includes these two measures, as almost as important as the operation itself.

The value of these measures in the acquired varieties cannot be overestimated. Especially is this true of infantile paralysis, in which massage not only keeps up the nutrition of the muscles and reduces the wasting, but assists in relaxing the shortened and contracted muscles and tendons. It should, if possible, be given by a person skilled in its use, and should not be continued too long at each application. Ten minutes is sufficient if but one leg be paralyzed. Electricity may be applied in one week in infantile paralysis, provided no fever nor hyperesthesia of the muscles be present, but for one month only the mildest currents may be employed. In deciding



FIG. 587.—CORRECTION OF CLUB-FOOT BY BANDAGE (Schreiber).

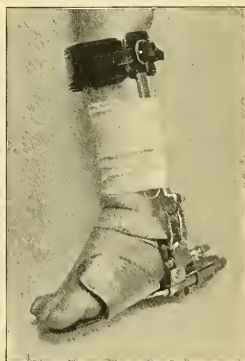


FIG. 588.—EQUINO-VARUS BRACE APPLIED.

between the faradic and galvanic currents, the current which gives the greater amount of contraction with the weakest current, and the least amount of pain, should be the one selected. The treatment must be used daily for a short duration only; four or more contractions for each muscle are sufficient. One pole (the anode) is best applied over the nerve-trunk, and the other (the cathode) is successively applied firmly over the entire surface of the limb.

The **splints** employed in the treatment of club-foot may be divided into two classes: first, apparatus intended to correct the faulty position; second, apparatus employed to retain the foot in a corrected position. These can best be described under the varieties for which they are designed, and the principles upon which they act need only here be mentioned.

Of all the corrective apparatus in use the internal lateral traction shoe of Shaffer is remarkable for its ingenuity. It consists of a steel trough fitted to the inner side of the leg, from the upper part of the tibia to the internal malleolus. From opposite the latter point a hinge, obliquely placed, connects this upright with the sole-plate. An endless screw acts upon this hinge in such a manner as to correct the deformity of the anterior portion of the foot. The sole-plate is divided opposite the mediotarsal joint, and by means of a simple screw and lever, or the more powerful triple screw of Roberts, allows of extreme and powerful abduction of the anterior portion of the foot.

The apparatus is applied to the foot in its deformed position, and by means of keys the correction is gradually accomplished by the action of this power-



FIG. 589.—DOUBLE EQUINO-VARUS BEFORE USE OF TRACTION SHOE.



FIG. 590.—SAME, AFTER USE OF TRACTION SHOE.

ful screw force. In a somewhat similar but still more powerful manner external lateral traction is applied.

The use of elastic traction has the advantage of not interfering with the free use of the joints and muscles, as well as simplicity of application, to recommend it. It consists essentially of a zinc plate fastened to the front of the leg by plaster, which serves as a fixed point of attachment for the elastic traction, and a fan-shaped piece of plaster cut into a number of strips and carrying a wire loop to serve for the second point of attachment. An elastic tube, with a hook at one end and a chain at the other, furnishes the traction force. Elastic traction is most valuable in paralytic deformities to supplement the action of the weaker muscles.

The retentive apparatus are employed in the intervals between the manipulations to maintain what has been secured, or are applied after tenotomy and other cutting operations, to maintain the parts during the healing process. These may be constructed of metal (zinc, tin, lead, steel), rubber, felt, or prepared

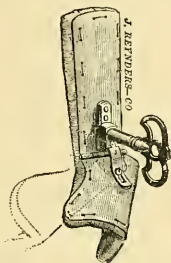


FIG. 591.—SHAFFER'S LATERAL SPLINT FOR CLUB-FOOT.

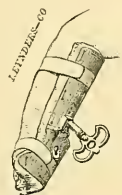


FIG. 592.—SHAFFER'S LATERAL SPLINT APPLIED.

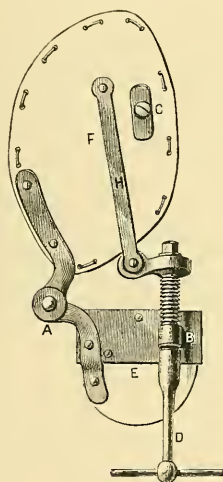


FIG. 593.—SOLE-PLATE EXTENDED.

A, Lateral hinge; B, screw; C, toe plate; D, key; E, heel plate; F, sole plate.

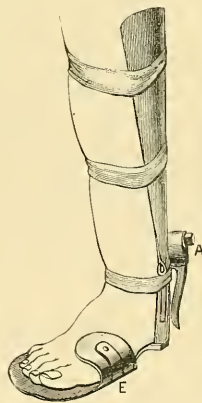


FIG. 594.—BRACE ADJUSTED TO CORRECTED POSITION.

A, Screw; E, foot plate.

leather, and retained by an ordinary roller or plaster-of-Paris bandage. More elaborate apparatus are sometimes employed. The plaster-of-Paris cast, well applied, furnishes the simplest, neatest, and best retentive apparatus. In small children, and when the dressing is carried high up the thigh, the plaster-

of-Paris dressing should be reinforced with a silicate of soda bandage or coated with shellac to render it impervious to water. The dressing should be removed and reapplied every week or ten days, at which time the limb should be washed with soap and water, and vigorously rubbed with alcohol or soap-liniment.

The operative treatment of club-foot, the remarkable success of which has already been mentioned, includes tenotomy, syndesmotomy, myotomy, tarsectomy, tarsotomy, *brisement forcé*, and amputation.

Tenotomy.—Surgeons differ much as to the proper time at which to perform tenotomy in club-foot, some operating very early, within the first month,—Stromeyer operated upon one within twenty-four hours of birth,—and others delaying until the child shows an inclination to walk. Since in all instances it is proper to endeavor first to correct the deformity by manual and mechanical

means, and, failing in this, to resort to operative procedures, a later period appears to me preferable. Much will depend upon the individual case, but from eight to twelve months would appear to be a good time to operate upon infantile cases. The later period has also this advantage, that failing by subcutaneous tenotomy to rectify the deformity entirely, resort can at once be made to other surgical procedures, to be discussed presently.

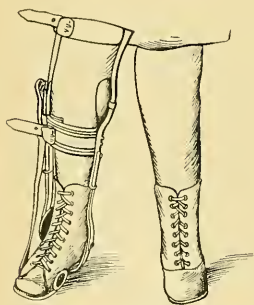


FIG. 595.—CLUB-FOOT WALKING SHOE.

The individual tendons most frequently requiring division in club-foot are, in the order named, the tendo Achillis, tibialis anticus, tibialis posticus, plantar fascia, and peronei. The technic of the division of each has been described under the general head of treatment in Part I.

Syndesmotomy.—In some instances the contractures of the ligaments, as the astragalo-scapoid and calcaneo-cuboid ligaments in talipes equino-varus, offer the greatest resistance to the reduction of the deformity, and the division of these has, therefore, been advised by many surgeons. The division of these ligaments may be performed by the percutaneous and subcutaneous methods. Phelps, in his open incision, has advised the incision of the internal lateral or deltoid ligament and all its branches by an extensive subcutaneous curvilinear incision, the tenotome being introduced through the open incision. The astragalo-scapoid and calcaneo-cuboid ligaments, the ones most frequently requiring division, can both be divided subcutaneously. To divide the astragalo-

scaphoid ligament the tenotome held vertically, edge forward, is entered immediately in front of the anterior border of the internal malleolus, and passed between the skin and ligaments. The blade is turned toward the surface of the ligament, and by a gently sawing motion the division is accomplished. By directing the point of the knife to the plantar aspect of the foot and keeping close to the bone, the calcaneo-scapoid ligament may also be easily divided. To divide the long and short plantar (calcaneo-cuboid) ligaments, the tenotome must be entered behind the head of the fifth metatarsal bone, as nearly as possible over the calcaneo-cuboid articulation on the outer border of the sole of the foot. The blade is passed close to the bone in the direction of the articulation, and the section of the two ligaments may be accomplished simultaneously.

Myotomy.—The division of the



FIG. 596.—DOUBLE EQUINO-VARUS BEFORE MULTIPLE TENOTOMIES.



FIG. 597.—SAME, AFTER MULTIPLE TENOTOMIES.

muscles for club-foot is but seldom resorted to at the present time. In Phelps' operation the abductor pollicis and flexor brevis muscles are divided. Except in this operation, myotomy is rarely performed, and tenotomy, when possible, is always preferable.

Tarsectomy and Tarsotomy.—The cutting operations upon the tarsal bones for the relief of talipes—about eighteen separate operations in all—are included under these two heads; the former, tarsectomy, consisting of the removal of a wedge-shaped piece of bone; the latter, tarsotomy, consisting of the division of the bony structure of the tarsus with an osteotome.

The following enumeration, slightly modified from Roberts' and Ketch's valuable article, includes all to the present time:

1. Linear osteotomy of the scaphoid practised on the plantar surface. (Hahn.)
2. Linear osteotomy of the tibia above the malleolus. (Hahn.)
3. Enucleation of the cuboid. (Solly.)
4. Enucleation of the astragalus alone. (Lund, Maron.)



FIG. 598.—ASTRAGALECTOMY, SHOWING CICATRIX.

5. Same, with resection of tip of external malleolus. (Mason, Reid.)
6. Excavation of the spongy portion of astragalus, leaving the articular surfaces. (Verebely).
7. Enucleation of astragalus and excision of a wedge-shaped piece from anterior part of os calcis. (Hahn.)
8. Enucleation of astragalus and cuboid. (Albert, Hahn.) Enucleation of astragalus and scaphoid. (West.)
9. Enucleation of astragalus, cuboid, and scaphoid. (West.)

10. Enucleation of scaphoid and cuboid. (Bernet.)
11. Resection of head of astragalus. (Lücke, Albert.)
12. Excision of wedge from outer half of neck of astragalus. $\frac{1}{2}$ (Hueter.)



FIG. 599.—AUTHOR'S CASE, BEFORE ASTRAGALECTOMY.



FIG. 600.—SAME, AFTER OPERATION.

13. Excision of two wedges perpendicular to each other, with bases at Chopart's articulation and the astragalo-calcaneal joint. (Rydygier.)

14. Resection of a wedge without regard to any individual bones. (O. Weber, Davies-Colley, R. Davy.)

15. Linear osteotomy of the lower end of the tibia and fibula. (Trendelenburg, Willy Meyer.)
16. Linear osteotomy of the neck of the astragalus. (Bradford.)
17. Removal of section of lower fifth of fibula. (Barton Hopkins.)
18. Excision of astragalus, scaphoid, cuboid, and anterior part of the os calcis. (Verneuil.)

Of these eighteen operations two only, which are most employed, will be described, the others being either unsatisfactory, insufficient, or too mutilatory. These three are: enucleation of the astragalus, and wedge-shaped tarsectomy.

Astragalectomy, or enucleation of the astragalus, in inveterate cases of club-foot is best performed as follows: The foot, duly prepared, is supported in a strongly inverted position upon a triangular block. An incision extending from just above the tip of the external malleolus is carried forward and a little inward, curving toward the dorsum of the foot. This crosses a space between the peronei tendons, in which no important structures are found, and being carried directly down to the bone, the latter may be readily exposed and removed to avoid bruising the surrounding bony structures, and in dressing the strictest aseptic precautions should be enforced.

Tarsectomy, or *resection of a wedge-shaped piece from the outer side*, is best performed after the methods of Davies-Colley and Davy.

The cleansed foot is supported on a triangular block and a T-shaped incision made upon the outer side of the foot. The straight incision is carried along the outer border of the foot, from the middle of the os calcis to the middle of the fifth metatarsal bone. The vertical incision at right angles to the center of this enlarges the field of operation. The flaps are reflected, the tendons and vessels are held aside upon the dorsal and plantar surfaces with a periosteal elevator and retractor, and with a narrow-bladed saw or a chisel a wedge-shaped section is removed with a lion-jaw forceps from the tarsus, irrespective of the individual bones involved, sufficient in size to allow of the correction of the deformity. This section will include a portion of the os calcis and a portion of the cuboid—the entire cuboid or even a portion of the fifth metatarsal bone being removed in the severest cases. The tendons, if any have been divided, should be united with silk or chromicized catgut, the vessels secured, a rubber drainage-tube inserted, and the wound partially closed with wire sutures. A full aseptic dressing is then applied. The foot is then secured in a plaster-of-Paris dressing or some suitable retentive apparatus. The strictest aseptic precautions are essential to success and the safety of the patient, and



FIG. 601.—ASTRAGALECTOMY. RIGHT, FOOT SHOWING RESULT.



FIG. 602.—SAME AS FIG. 601, LEFT FOOT.

during the subsequent treatment care should be taken to keep the wound aseptic.



FIG. 603.—BEFORE FORCIBLE CORRECTION. FRONT VIEW.



FIG. 604.—BEFORE FORCIBLE CORRECTION. BACK VIEW.

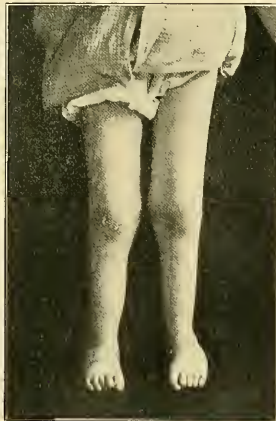


FIG. 605.—SAME, SHOWING RESULT OF FORCIBLE CORRECTION.

These two operative procedures, in addition to tenotomy and open incision, are all that are required even in the most severe cases, and while in

many cases they offer a means of quickly and brilliantly correcting very severe deformities, their field of application should always be restricted, and in no instance should they be undertaken unless the surgeon is confident that aseptic measures can be faithfully enforced. The relative merits of astragalectomy and wedge-shaped tarsectomy have given rise to much discussion, which has resulted in the substitution of astragalectomy and other methods for wedge-shaped tarsectomy. The objections to the latter may be briefly stated as follows:

It shortens the outer side of the foot.

It impairs the form of the foot, the stability, mobility, and usefulness of the osseous arch, and

It exposes to infection an extensive surface of cancellous tissue.

The objections to the cutting operations upon the bones in general (resections of the tarsus) may be briefly stated as follows:

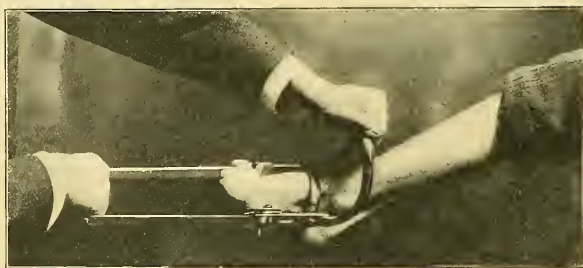


FIG. 606.—McKENZIE CLUB-FOOT WRENCH APPLIED.

1. Resection as an operation is not free from risk.
2. Resection removes all chance of future restoration by orthopedic treatment.
3. Resection is unjustifiable except in persistently painful club-foot in an old subject, where all orthopedic treatment has failed, and where it (resection) may be employed in preference to amputation.

In conclusion, excision of the tarsus should never be postponed before the fifth year, and, preferably, from the twelfth to the fourteenth year, and where possible enucleation of the astragalus should have the preference over all other bone-cutting operations.

Brisement forcé.—Under this title are included all operations which aim at the immediate forcible restoration of the foot, either by the hand or power-

ful instruments. It is necessary in all cases to employ an anesthetic, to economize time and save the patient much suffering. It is remarkable how much can be accomplished by manual means alone, but when great force is to be applied, the club-foot wrenches of Thomas, Gibney, and McKenzie, the club-foot stretchers of Morton or Bradford, or the club-foot machine of Phelps, should be employed. The objection to the wrenches is the limited application of force and the difficulty of rapid removal of the apparatus after the reduction is accomplished. The Bradford stretcher has this advantage over the Morton apparatus, that the force is applied by screw power, and does not yield as do



FIG. 607.—LINE OF INCISION AND POSITION OF FOOT AFTER PHELPS' OPERATION (McKenzie).



FIG. 608.—POSITION OF FOOT AFTER PHELPS' OPERATION, SHOWING LARGE BURSA ON OUTER SIDE OF FOOT (McKenzie).

the leather straps of the former. The Phelps machine has the advantage of being adapted to apply any amount of force from a single pound to a ton. The chief objections urged against all these methods of forcible restoration are the supposed risks incurred—the sloughing of the skin, the rupture of the ligaments, and the breaking of bones. Experience in osteoclasy, however, proves that these fears are more theoretic than real. The pressure applied to the skin is so momentary that sloughs seldom occur, and the ruptured and stretched tendons readily heal in the fixed apparatus subsequently applied; fractures seldom or never occur.

Open Incision.—In selected cases, where the skiagraph shows that there is no bony interference with the replacement of the astragalus in its normal position, the operation of Phelps is to be recommended. After excluding all cases which by manipulation or force can immediately, or in a reasonable length of time, be restored, the following rules should be followed: "Cut the contracted parts as they first offer resistance, cutting in the order of those parts which first contracted when the deformity was produced. The operator will then proceed, after strong manipulation or force is applied with a club-foot machine or hands, to subcutaneously divide the tendo Achillis. *If the skin is not short*, subcutane-



September, 1890.

May 4, 1891.

May 9, 1891.

FIG. 609.—SHOWING RESULT IN PHELPS' OPERATION (McKenzie).

ous tenotomy in the sole of the foot will usually suffice. *If the skin is short*, an open incision one-fourth the distance across the foot can be made, beginning directly in front of the inner malleolus and carried down to the inner side of the neck of the astragalus. Through this incision the following tissues can be cut, if they offer strong resistance, in the order given: (a) Tibialis posticus; (b) division of abductor pollicis; (c) division of plantar fascia through the wound; (d) division of flexor brevis muscle; (e) division of long flexors; (f) division of deltoid ligament or its branches."

The parts are thoroughly prepared for the operation, an Esmarch bandage is applied, the wound is thoroughly irrigated with bichlorid solution, 1 : 2000,

during the operation, and a full antiseptic dressing is applied before the bandage is removed, the foot being subsequently slung to a nearly perpendicular position for six hours or longer. In this manner Phelps performed 161 operations in 93 cases, the average age being six and a half years, and the average time of the healing of the wound four weeks. In 140 of these cases, 117 healed by blood-clot organization, 4 by catgut dressing in the wound, and 19 were failures. Four months after operating the feet were all straight, but out of 140 cases traced after one year, 10 cases were found relapsed, or partially so, from neglect. In these cases there were, in all, 17 osteotomies performed.

Amputation.—In the severer forms of club-foot, especially when complicated with bursitis and extensive ulceration, the individual is rendered practically helpless, and relief is sometimes sought in amputation of the affected parts. Operations of this kind at the present time are exceedingly rare, since with improved orthopedic measures even the most severe cases may now be rendered more or less useful.

VARIETIES—SPECIALLY CONSIDERED.

As pointed out before, the purely primitive forms are so rare that writers have usually considered the compound varieties under the simple forms, but to avoid confusion, which otherwise occurs where this plan is followed, each variety will be separately considered, especially concerning its morbid anatomy and pathology.

SIMPLE FORMS OF CLUB-FOOT.

Talipes Varus.

Synonyms.—*English*, Supination Contracture; Adduction Contracture. *German*, Klumpfuss. *French*, Pied-bot Varus. *Italian*, Piede torto; Storto del piede. *Spanish*, Pié trncado.

As a pure pes varus this variety of club-foot is one of the rarest, but as a part of the congenital equino-varus it is exceedingly common. As a purely primitive type the deviation inward of the anterior portion of the foot, and its supination and adduction, occur at the tibio-tarsal articulation, the deformity being entirely upon a lateral plane. In severe cases the internal border is elevated, the sole curved inward, and the external border depressed. It may here be remarked that in most infants at birth there exists a tendency to varus, which disappears as the child attempts to walk.



FIG. 610.—TALIPES VARUS.

The morbid anatomy of this rare affection will be described under the compound form—equino-varus.

Talipes Valgus.

Synonyms.—*English*, Flat-foot; Splay-foot. *French*, Pied-bot Valgus. *German*, Plattfuss.

This variety occurs both as a congenital and an acquired affection, the former being rare and usually of the compound variety—equino-valgus; the latter being very common, occurring also as a compound form—calcaneo-valgus. The frequency of this form is well shown in the interesting statistics collected by Hoffa in the Münchener Poliklinik. Of the 17,619 surgical affections, 338, or 0.49 per cent., were flat-foot; of 1444 deformities, 338, or 23.41 per cent., were flat-foot. Out of 235 cases, he found that 10, or 4.5 per cent., were congenital, and 225, or 95.7 per cent., were acquired. Of these 225 cases, 11, or 4.9 per cent., were traumatic; 7, or 3.1 per cent., were paralytic; 7, or 3.1 per cent., were rachitic; 200, or 88.9 per cent., were static.

Flat-foot often coexists with lateral curvature as cause and effect.

Congenital Valgus.

As a congenital affection, in its mildest form it is often found at birth, but seldom in such a degree as to be considered pathologic. It is, moreover, a well-established fact that all infants on commencing to walk are flat-footed, and do not acquire a perfect plantar arch until they have exercised some time and the leg muscles have become developed.

Of well-marked congenital valgus, Adams found 42 cases in 764 patients afflicted with congenital deformity of the feet, and Küstner found 13 cases of well-marked valgus in 150 newborn infants taken consecutively.

The statement that most infants have flat-foot, with a tendency to varus, may seem paradoxical, but when it is understood that the varus relates to the inverted position of the anterior portion of the foot, and the valgus, or flat-foot, to the sole of the foot, the correctness of the statement will be evident.

Numerous observers have noted that at birth most infants have a distinct arch, which persists for eighteen months, after which a breaking-down of the arch occurs, but is followed in a few years by its restoration.

As a persistent congenital deformity three degrees of severity have been established, according to the amount of outward deviation of the anterior part of the foot—slight, intermediate, and severe. In the severer forms the entire

sole of the foot rests upon the ground, the internal border is lengthened, and the external border shortened and creased over the medio-tarsal articulation, or the foot may even be rotated outward, the sole being everted and turned backward.

From dissections made of congenital valgus the pathologic condition of the foot has been noted. According to these, the astragalus is tilted downward and forward, the head depressed on its outer side, its upper part projecting from the rotation of the scaphoid, and the changed direction of the astragalo-scaphoid articulation. The tuberosity of the os calcis is short and thrown forward. The cuboid and scaphoid are rotated inward. The malleoli are depressed, the inner one resting in severe cases upon the ground.

Acquired Valgus.

Synonyms.—Splay-foot; Flat-foot.

As an acquired affection flat-foot is most common from infancy to adolescence, seldom becoming a serious deformity until the latter period, and always occurring in one of two forms—either as *pes valgus paralytica*, resulting from poliomyelitis anterior, or as *pes valgus acquisitus*, resulting from simple muscular relaxation, as seen in association with rachitis or as a sequel of burns, traumatism, osteitis of the tarsus, or ankle-joint disease.

Three degrees, or stages, as in the congenital variety, have usually been recognized—mild, medium, and severe.

1. The mild variety is that in which the deformity is present during the erect position only.
2. The medium variety is that in which the deformity is present at all times, but is not especially marked.
3. The severe variety is characterized by an aggravation of all the symptoms to a marked degree.

Numerous theories have been advanced as to the mode of production of flat-foot. The muscles, tendons, ligaments, bones, fascias, and even an improper mechanical construction, have each been considered the chief factors in its production.

Some authorities believe that the normally constructed human foot is incorrect anatomically, saying that the lower end of the tibia is placed too much toward the inner border of the foot, and claiming this as the primary cause. Others believe that atony of the plantar fascia and the tarsal interosseous liga-

ments were responsible, while still others consider it due to a rotation of the astragalus inward and pressure atrophy of the bones; to muscular contraction, first of the extensors and then of the pronators; or to muscular insufficiency and body-pressure, an explanation first proposed by Duchenne, who considered the peroneus longus particularly at fault.

Of these theories, the last has always appeared to me the most satisfactory: that it is a muscular affection from the first. Thus, muscular relaxation, either from debility or paralysis of the peroneus longus, leads to an improper distribution of the body-weight upon the tarsal arches, which, by undue pressure upon the interosseous ligaments, especially the inferior calcaneo-scapoid and calcaneo-cuboid ligaments and plantar fascia, induces their subsequent relaxation, stretching, and obliteration of the normal arch.

In some instances the inflammatory variety follows systemic infections, especially typhoid fever and gonorrhea.

The symptoms differ in the two varieties—pes valgus acquisitus and pes paralytica—but in each are characteristic.

(a) **Pes Valgus Acquisitus.**—**Synonyms:** *English*, Talipes Valgus Spurius; Inflammatory or Acute Flat-foot; Tarsalgia of Adolescents; Contractured Static Flat-foot. *Italian*, Piede da pianezza; Piede spianato. *Spanish*, Pié plano. *German*, Pes valgus. *French*, Pied plat valgus acquis de l'adolescence.

Patients suffering from pes valgus acquisitus have an attitude and walk that are characteristic. They stand with the feet everted, resting on the inner side of the sole, with the knees in a flexed valgoid position, and walk with a difficult, heavy gait, the knees flexed and the feet placed everted flat upon the ground in an uncertain, careful manner. Such patients have an expression of anxiety, tire easily, and complain of great pain of a dull, aching character, or sharp, excruciating in nature, about the inner malleolus, instep, or ball of the great toe, accompanied in some cases with swelling. The pain is sometimes very acute. I have known individuals to fall in the street from the pain of this affection and to be taken to the hospital and treated for sprains. The bilateral character of this affection should serve to distinguish it. On inspection the external appearance varies with the degree. In the mild variety the plantar arch is depressed, the inner malleolus lowered and prominent; the foot is cold, bluish, and perspires freely, and the angle of deflection is found reduced from thirty-four degrees normal to about twelve degrees in mild, to eight degrees in severe, cases. The patient cannot raise himself on his toes, but the deformity can be readily corrected by manual pressure.

In the medium variety all these conditions are exaggerated, the foot is completely flattened and somewhat everted, the inner side presents two prominences below and anterior to the internal malleolus, the head of the astragalus, and the tubercle of the scaphoid; and on taking an outline the angle of deflection is found reduced to probably eight degrees. The pain is common about the inner lower portion of the astragalus, and may be so severe as to render exercise intolerable. Sometimes there is a tender spot in the plantar fascia over the calcaneo-scapoid articulation. The arch can still be restored, and the deformity is not prominent.

In the severe variety the foot is more everted, making an angle of deflection in severe cases as low as five degrees. This is due to functional paresis of the peroneus longus, and increased reflex contraction of the peroneus brevis, tertius, and extensor communis digitorum. The pain is increased by the unbalanced action of muscles, giving a painful spot at the base of the first metatarsal bone; direct pressure upon the ligaments causes points of tenderness to develop over the calcaneo-cuboid and astragalo-scapoid articulations; and from direct pressure upon the plantar nerves pain is referred to their distribution. Fibrous and osseous changes have occurred, and so the arch cannot be restored without some operative procedure.

The pathology of the affection was for some time obscure, especially of the non-paralytic valgus, it being supposed at one time to be inflammatory. Such cases have frequently been mistaken and actively treated for inflammatory lesions of the bones or ligaments; complete inflammation, with effusion of lymph, serum, or pus, never occurs, however. All the inflammatory symptoms are simply the result of pressure.

The extensors, particularly the peroneus longus, from some cause, become relaxed. This is followed by stretching and elongation of the plantar muscles and tendons, the long and short plantar ligaments, the calcaneo-cuboid and astragalo-scapoid ligaments, and the plantar fascia, and a giving way of the inner antero-posterior arch. The astragalus is pushed downward, forward, and inward; the scaphoid is rotated, the internal surface downward and the external

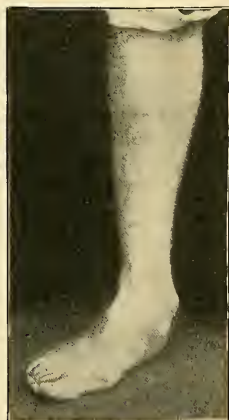


FIG. 611.—MEDIUM DEGREE OF FLAT-FOOT.

surface upward; the ligaments, generally on the inner and plantar surfaces of the bones, are stretched, the joint surfaces separated on the plantar and crowded together on the dorsal aspect. This may become so great that the bones entering into the medio-tarsal (Chopart's) joint divide, the anterior portion resting upon the ground, the posterior portion being drawn up by the extensors of the foot so that the heel does not touch the floor, making the so-called "canoe-shaped sole." The articular surfaces become eroded from the continued pressure, and osseous ankylosis renders the deformity permanent. The diagnosis in many cases can readily be made, but in others, especially the inflammatory variety, with which we are most concerned, very careful attention is required to avoid confounding it with other conditions.

From the congenital forms of valgus it can be distinguished by the latter always being bilateral and the peroneus responding to electric stimulus. (The slight normal tendency to flat-foot observed in infants has already been referred to.) Its occurrence about the period of adolescence, the previous history of rheumatism, knock-knee, bow-legs, lateral curvature, traumatism, bone or joint disease, all should be carefully inquired into.

It is most commonly mistaken for rheumatism, of which it may be a sequel, and for inflammatory conditions of the tarsal and metatarsal joints or ligaments. Its angle of deflection determined from the outline will be the best single symptom to distinguish it from the former, and the same with reflex muscular contraction, or a collection of inflammatory fluid, from the latter. The lesions from which it would be most difficult to distinguish it are the early stages of perforating ulcer, and such neuropathies as Charcot's joint disease. From these in the earlier stages a differential diagnosis cannot be made, but the subsequent course would soon decide the true nature of the affection.

The prognosis will depend on the cause and general condition and surroundings of the patient and degree of the deformity. If advice is sought early, and the disease is still in the first or even second degree, the prospects, under appropriate treatment, of great improvement or even complete cure are good. Certainly entire relief of pain may be expected. If, however, ligamentous or osseous ankylosis has occurred, some relief may yet be hoped for, but resort must be had to *brisement forcé*, or tarsectomy, before the deformity can be overcome.

(b) **Pes Valgus Paralytica.**—As a result of infantile paralysis (poliomyelitis anterior) paralytic flat-foot is favored by the flail-like condition of the foot upon the ankle-joint, the relaxed ligaments, and the action of gravity, and is

aggravated by bearing the body-weight upon the foot in its weakened everted position. Neglected cases grow progressively worse until the severest grades are reached. This tendency is increased by the action of those muscles which are antagonistic to the paralyzed muscles.

These deformities gradually become permanent and are not dependent upon tonic retraction; nor is the shortening of the muscles due to contraction, but to the growth of the limb, the foot remaining in its deformed position. This is particularly true of the peronei group of tendons, which often stand out prominently behind the external malleolus. The walk of patients suffering with paralytic valgus is peculiar and characteristic. The everted foot is thrown outward and forward, describing the arc of a circle, the center of which corresponds to the position of the other foot. The foot rolls inward and the body sinks downward on that side as the superincumbent weight is thrown upon it. The sound foot is brought forward and the act is repeated, giving to the patient an oscillating progression. Aside from the general paralysis of the muscles the morbid anatomy of this variety of flat-foot is identical with that of the pes valgus acquisitis, and need not be here repeated.

The prognosis is influenced by the degree of the deformity and the amount of paralysis. The paralyzed muscles cannot be restored, but the position and usefulness of the foot can be much improved by appropriate measures. The electric reactions of the muscles establish the diagnosis of the deformity.

Talipes Equinus.

Synonyms.—*French*, Pied-bot Equine. *German*, Spitzfuss; Pferdehuss. *Italian*, Talipe equina. *Spanish*, Talipes equina.

As a primitive form talipes equinus may be either acquired or congenital. The former as a paralytic deformity is common, but the latter is very infrequent, its very existence being sometimes denied.

The most common causes of acquired equinus are infantile spinal paralysis, spastic paralysis, post-hemiplegic contractions, protracted decubitus, as typhoid, typhus, etc.; inflammation of the ankle-joint; wounds, burns, cicatrices, abscesses, etc., of the calf of the leg; hysteria, or neuromimesis. Compensatory equinus occurs from a shortening of the extremity from any cause, as hip disease, fracture, etc. The foot is extended upon the



FIG. 612.—TALIPES EQUINUS.

leg, varying in degree from a condition in which the foot is a trifle over 90 degrees in relation to the leg, to one in which the foot is in a continuous line with the leg or even beyond 180 degrees. According to the degree of deformity the external appearance, the walk of the patient, and the structural changes vary greatly. In the mildest form the general appearance of the foot is but little changed. In the severer grades the arch is increased, the plantar surface diminished, the plantar fascia contracted, the toes are extended, the calf muscles, particularly in the paralytic forms, are shrunk. When the foot is retroverted, the skin of the dorsum becomes callous, thickened, and inflamed from walking upon it.

In mild cases locomotion is but little affected, the increased length of the extremity being overcome by flexion of the knee. The individual walks upon the ball of the foot and toes alone, dragging the limb or swinging it forward by circular movements. When the foot is retroverted, it becomes practically useless.

The morbid anatomy of equinus consists essentially of a contraction of the superficial extensor muscles and a relaxation or paralysis of the flexors of the leg. The bones of the foot may be unaltered, or they may be and usually are much deformed in severe cases. The astragalus projects prominently on the dorsum of the foot, the head projecting free above the astragalo-scaphoid articulation, and the scaphoid being subluxated. The articular surface of the astragalus extends further posteriorly than normal. The calcaneo-cuboid articulation is likewise affected, the anterior portion of the os calcis being subluxated. The ligaments on the plantar surface and the plantar fascia become contracted; those on the dorsal surface become elongated.

The diagnosis should always be made with the knee extended, as this increases the deformity. The previous history is important in determining the cause.

The prognosis in general is good, particularly if osseous changes have not occurred.

Talipes Calcaneus.

Synonyms.—*French*, Pied-bot Talus; Pied-bot Calcanien. *German*, Hakenfuss. *Italian*, Talipe calcanea. *Spanish*, Talipes calcanea.

This deformity, the direct opposite of the equinus, occurs as both a congenital and an acquired affection, but as a purely primitive form it is the rarest of all the varieties. Associated with valgus—as calcaneo-valgus—it is quite

common. The deformity consists of a flexion of the foot upon the leg at the tibio-tarsal articulation.

As a congenital affection it may be the remains of the normal intrauterine position of flexion, or may depend upon intrauterine disturbances. According to Adams, it is common in breech cases with extended limbs. In congenital cases the foot is observed to be flexed upon the leg, and on attempting to walk, only the heel comes in contact with the ground. The dorsum of the foot is shortened and wrinkled. The plantar surface later becomes somewhat concave (*pes cavus*) from the action of the flexors of the foot and of the deep extensors of the leg.

According to the degree of deformity, three grades of congenital calcaneus have been described, depending upon whether the foot forms a right angle or an acute angle with the leg, or whether its dorsum touches the anterior surface of the leg.

Considering the amount of deformity, the tarsal bones are not much altered, the changes being principally in the articular surfaces. The astragalus seems to be displaced backward toward the posterior part of the *os calcis*, and rotated backward so that its neck comes in contact with the inferior tibio-fibular surfaces, the anterior part of its upper articular surface lying uncovered behind the tibia. The posterior part of the *os calcis* may be bent downward and the tubercle displaced slightly forward. The superficial extensors—*gastrocnemius*, *soleus*, and *plantaris*—are usually atrophied; the deep muscles are usually normal.

As an acquired affection it frequently results from infantile paralysis, caries of the ankle-joint, wounds, burns, cicatrices, rupture of the *tendo Achillis*, rapid stretching of the *tendo Achillis* after tenotomy, etc. Cases are also recorded from pathologic displacement of the epiphyses, following osteomyelitis, and from spontaneous separation of the epiphysis.

In the acquired form, particularly the paralytic variety, the relation of the foot to the leg is much the same; but there is usually a greater tendency to *cavus*, from the retraction of the plantar muscles and fascia. The *extensor proprius pollicis*, *extensor longus digitorum*, *tibialis anticus*, and sometimes the *peroneus tertius*, are all involved. The leg and foot are much atrophied, and the skin cold and purplish. The bones are more displaced, and the ligaments are lengthened posterior to the ankle.

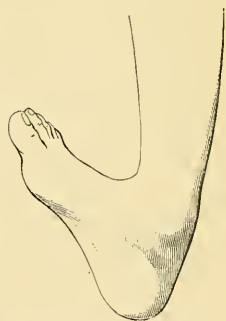


FIG. 613.—TALIPES CALCANEUS.

There is no difficulty about the diagnosis of this deformity, and the prognosis in the congenital cases is excellent. The acquired variety can be much improved by suitable mechanical means, but the paralytic nature of the majority of these cases precludes the possibility of absolute cure.

Artificial Calcaneus.

The deformed feet of Chinese women bear a close resemblance to, if not an exact identity with, this deformity, especially in its severer forms, and have been described as *artificial calcaneo-cavus*.

This artificial deformity is effected early in life, about the fifth year, by an ingenious method of foot-binding, peculiar to the Chinese proper and not accepted by the Manchu Tartars, or reigning power. The process of production has been well described by Harris, to whom we are indebted for the following:

“There are,” he says, “three points to be gained by the binding, which collectively, and under the influence of an atrophic action, the result of defective nutrition, make the feet small, and give the skin of both feet and legs a shriveled appearance. The first step, and that to which the parts make the least resistance, is the bending of the four smaller toes under the sole of the foot, and the narrowing of the parts supported by the metatarsal bones. The second step is best accomplished in early childhood, when the tarsal bones appear to move with a joint-like flexibility upon each other, and consists in a forcing together of the plantar portions of these bones, whereby they are subjected to a continuous pressure, and in an opening, or rather attempt at opening, of the articular crevices of the instep, keeping their ligaments constantly tense at the same time. The third step is the last to be accomplished, and can only be completed in the young subject. The os calcis, with the astragalus, is forced downward until the heel is vertical and its bone on a line with those of the leg. The calcis is rounded in form, losing its processes, which are so prominent in the normal bone; and its anterior articulating face is brought up near the high, instep-like arch just in front of the ankle-joint, while at the same time the point of attachment of the tendo Achillis is made the base upon which the girl stands when erect, and steps in walking.”

The anatomic changes are well shown both externally and by dissection. The characteristics are the bending under of the four smaller toes, especially the disproportionate size and length of the fifth toe, which reach to or even beyond the central line of the sole; the deep indentation of the sole at the medio-tarsal articulation, which, when perfected, amounts to a mere fissure an inch and a

half deep; the vertical direction of the os calcis, and its square base; the height and prominence of the instep; the posterior position of the external ankle; and the diminutive circumference of the ankle.

Dissections have been made and almost every museum possesses dried specimens and casts of this interesting deformity.

COMPOUND FORMS OF CLUB-FOOT.

Talipes Equino-varus.

Synonyms.—*English*, Club-foot; Reel-foot; Stump-foot; Pes Contortus. *German*, Klumpfuss. *French*, Pied-bot Varus. *Italian*, Piede de storto. *Spanish*, Talipes equinovara.

This, the most common variety of club-foot, may be either congenital or acquired. It is the most frequent of all the congenital deformities.

The deformity is threefold: the heel is elevated, the anterior portion of the foot is adducted, and the internal border of the foot is raised upward.

Three forms of either the congenital or acquired varieties have been distinguished:

1. Mild, or where the foot can still be brought into its normal position and the angle between the foot and the lower extremity is greater than 90 degrees.
2. Medium, or where correction is not possible to such a degree, the foot being drawn more internally.
3. Severe, or where it is impossible to correct the deformity manually, the foot being at an acute angle with the inner surface of the lower extremity, all the tissues on the inner side being shortened.

The acquired forms may result from one of three causes: (1) nervous, either spastic, as from tetanoid paraplegia, spinal sclerosis, pseudo-hypertrophic paralysis; or paralytic, especially infantile or progressive muscular atrophy; (2) traumatic, such as fractures, dislocations, sprains, etc., in the neighborhood of the tibio-tarsal or mid-tarsal articulations; (3) articular, from chronic joint affections of the same articulations.

Congenital Equino-varus.

In severe congenital equino-varus the anterior portion of the foot is turned inward, the adduction ranging from 40 degrees to 63 degrees, with an average of about 51 degrees; the sole is directed backward, and its inner border directly upward; the heel is small and misshapen; the internal malleolus less prominent,

the external more prominent than normal and located more downward and backward. The dorsum of the foot is irregular, through the prominence of the head of the astragalus and anterior extremity of the os calcis, and the obliquity of the neck of the astragalus.

In cases of greater severity the inner edge of the foot may approximate the inner side of the leg, and the great toe is separated from the second by the contraction of the extensor pollicis muscle.

The **morbid anatomy** in congenital equino-varus consists in marked



FIG. 614.—TALIPES EQUINO-VARUS (LEFT) (Burrell).



FIG. 615.—NORMAL FOOT (RIGHT) (Burrell).

changes of all the structures except the muscles, which at birth are almost always healthy, but soon atrophy from disuse.

The *os calcis* is altered both in form and position. Its form in severe cases is slightly concave on the inner side. Its position in severe cases is more oblique, almost vertical, from the contraction of the superficial calf muscles, and the anterior extremity is directed obliquely forward and inward. Its tuberosity is directed outward and in severe cases is in contact with the fibula.

The *astragalus* is altered in position and form and rotated on an antero-posterior axis. It is tilted obliquely forward and downward and the superior

articular surface is somewhat displaced, the anterior portion being prominent on the dorsum of the foot. The lateral facets of this articulating surface are extended from the ankle-joint forward. The neck of the bone is deflected obliquely inward, forming an obtuse angle with the body of the bone, bearing a strong resemblance to the os calcis of the ape.

While the normal angle of deflection amounts at birth to an average of 38 degrees, and in the adult healthy foot to $26\frac{1}{2}$ degrees, in congenital equino-varus it varies from 64 degrees to 31 degrees, the average being 49.5 degrees.

In consequence of this obliquity of the neck of the astragalus the articular head does not project directly forward, but in an antero-lateral direction, and in severe cases the surface has two articular facets instead of one, the larger of which articulates with the displaced scaphoid.

The *scaphoid* is not altered in form, but is drawn upward, inward, and backward by the tibialis posticus, assisted by the tibialis anticus and extensor proprius pollicis muscles.

The *cuboid* presents no alteration either in form or position. Later, as the effect of increased lateral growth, its shape, as seen from above, is quadrilateral rather than triangular.

The cuneiforms and metatarsals are inverted, but not otherwise altered in relation to one another or to the scaphoid and cuboid bones.

The *malleoli* in recent congenital cases are normal, but from the inward twisting of the lower portion of the tibia, there is an apparent deficiency of the internal malleolus, and an exaggerated projection of the external malleolus.

The *ligaments* are only markedly affected in the severe grades. In these the internal lateral, especially the deltoid portion of it, the ligaments on the plantar surface, the calcaneo-cuboid, calcaneo-scaphoid, and the plantar fascia are all contracted. The severity of the case might be judged by the ligamentous rigidity rather than by the external form, the ligaments being the only constant anatomic hindrance to rectification. The dorsal ligaments, the astragalo-scaphoid, and the anterior portion of the capsular ligament of the ankle-joint are elongated.

The *muscles* are at birth almost always healthy and retain their electric reactions. They are subject later, in uncorrected cases, to the atrophy of disuse. In rare cases hypertrophy of one or more muscles has been found.

The *tendons* are always much displaced and adapted to the altered position of the bones. A knowledge of the altered relations of the tibialis anticus, tibialis posticus, and tendo Achillis is of direct practical importance in per-

forming tenotomy. The tendon of the tibialis anticus, as it crosses the ankle-joint, is much displaced to the inner side, passing in severe cases obliquely downward across the internal malleolus.

The tendon of the tibialis posticus at the point usually selected for its division—just above the malleolus—is placed relatively more forward than in the normal foot, being exactly midway between the anterior and posterior borders of the leg on its internal aspect.

The tendo Achillis, in consequence of the lateral obliquity of the os calcis, is inclined toward the external malleolus, and consequently is further removed from the posterior tibial artery than normal. The relations of the other tendons, though altered, have no practical bearing. The vessels and nerves are contracted on the internal aspect. This contraction of the vessels, particularly the posterior tibial, should be remembered in forcible manual rectification of the foot, lest the circulation be arrested or the artery be ruptured.

In *neglected varus* and in uncorrected adult cases as the result of pressure in walking, the deformity is very greatly exaggerated. The inversion of the foot brings the part at right angles to the leg, the sole is directed upward and backward, the dorsum downward and forward, the latter becoming callous from walking; the heel is drawn up, and the foot is shorter than its opposite, from atrophy. A deep transverse groove marks the tibio-tarsal joint, and a deep longitudinal groove divides the sole. The calf muscles are much atrophied. There is slight motion at the ankle-joint, the feet in walking being lifted one over the other, a circumstance which probably gave origin to the term "reel-foot."

The anatomic changes are great. The astragalus is completely vertical in position, the neck is much elongated and misshapen, and the head has two articular facets at right angles to each other. The os calcis occupies an oblique, almost vertical position, its tuberosity being deflected toward the fibula. The body of the bone is curved, the convexity being outward.

The scaphoid is atrophied, compressed in its inner half, and drawn completely under the internal malleolus, its long axis being vertical and parallel to that of the astragalus instead of being at right angles to it.

The cuboid bone is displaced inward, exposing two-thirds or more of the anterior articular facet of the os calcis. In its altered position it sustains the greater part of the superincumbent weight, and becomes from pressure somewhat wedge-shaped from below upward.

The cuneiform bones are moved inward and upward together with the scaphoid and cuboid, to which they retain their normal relations.

The greatest deviation from the normal occurs in the metatarsal and phalangeal bones, which give to the deformity its characteristic appearance. These are placed at right angles with the inner side of the leg, or, in severe cases, are even inclined backward. The ligaments and tendons on the plantar surface are contracted, the muscles of the calf and sole of the foot are atrophied, and bursæ are developed on the dorsum and outer side of the foot. The skin becomes callous from pressure, but otherwise retains its natural appearance, differing in this respect from that in the paralytic variety. The deformity in severe cases is so great that the foot no longer resembles the normal member, but its appearance suggests the extremity of an animal; hence the popular names of "devil's hoof," "cow-foot," etc.



FIG. 616.—TALIPES EQUINO-VARUS.

Paralytic Equino-varus.

This, the most common variety of acquired equino-varus, is produced by the healthy muscles predominating over the paralyzed. The external appearances are not so severe nor so marked as in the congenital form. The foot is not rigidly fixed. The dorsal projections and plantar depressions are absent. The skin is purplish and cold, and the leg is atrophied and its outline obscured by a thick pad of fat. The bones of the tarsus are also usually atrophied, and the foot and limb are smaller and shorter than their fellows. Fatty degeneration of the paralyzed muscles commences early, differing in this respect from the muscular changes occurring in the congenital affection. Marked changes also occur in the tendons, these being often but one-half the size of those in the opposite leg.



FIG. 617.—TALIPES EQUINO-VALGUS.

Talipes Equino-valgus.

This deformity is characterized by an elevation of the heel, associated with an eversion of the anterior portion of the foot, combining the conditions present in the two simple varieties—equinus and valgus.

It may be either congenital or acquired, the latter variety being much the more common. As an acquired affection it includes many of the severer grades

of valgus, so that it would seem advisable in the nomenclature of club-foot either to do away with equino-valgus as a separate variety, or to add to its importance by classifying under this term a large number of severe deformities described hitherto as simple valgus. The external appearances, symptoms, and morbid anatomy have already been described under the two simple forms, and need not here be repeated.

The diagnosis depends upon the association of the two simple forms, and the prognosis will be much influenced by the amount of equinus present.



FIG. 618. — TALIPES CALCANEO-VARUS.

Talipes Calcaneo-varus.

In this variety the heel is without elevation or is even depressed, and the inner margin of the foot is raised, the sole contracted, with the dorsum prominent toward the outer side. It occurs as a congenital affection, but as an acquired deformity from paralysis or spasm it is exceedingly rare, and many authorities have doubted its existence.

As a congenital affection it results from a preponderance of action of the tibialis anticus, tibialis posticus, and contraction of plantar fascia. The degree of deformity is usually slight, and always unilateral. The external appearance, morbid anatomy, and symptoms are a combination of the two simple forms already described. A deformity resembling the one under consideration sometimes results from a partial correction of equino-varus, from omission to remedy adduction and plantar contraction, after improper section of the tendo Achillis. For this reason the modern method of first correcting the varus should always be adopted. The prognosis in the congenital variety is good.

Talipes Calcaneo-valgus.

This is characterized by a depression of the heel, associated with an elevation and abduction of the anterior part of the foot. It may be either congenital or acquired, being in either case due to contraction of the peronei and extensor longus digitorum muscles combined with contraction of the anterior tibial and extensor proprius pollicis muscles.

Being a compound variety it combines all the peculiarities of these two simple forms. As an acquired affection it usually results from paralysis or

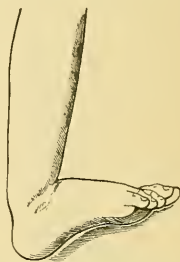


FIG. 619. — TALIPES CALCANEO-VALGUS.

articular disease. In infantile paralysis, the most common cause, the foot is abducted by the stronger action of the external extensors of the toes and the peroneus brevis. This, as pointed out under valgus, is increased by the growth of the limb, the foot remaining in its deformed position. The diagnosis is easy, and the prognosis in the congenital cases is excellent; in the acquired cases it will depend upon the amount of paralysis present, and will be much improved by operative and mechanical measures.

OTHER FORMS OF CLUB-FOOT.

Pes Cavus.

Synonyms.—*English*, Hollow-foot; Talipes arcuatus; Talipes plantaris. *German*, Hohlfuss. *French*, Pied Creux; Pied-bot Talus. *Italian*, Piede de cavo. *Spanish*, Pié cavo.

This consists of an elevation of the arch and an excavation of the sole of the foot. It may be either congenital or acquired, though the former is rare. As an acquired affection it results usually from paralysis of the superficial calf muscles, the gastrocnemii, and soleus. It may also result from a contracted condition of the tibialis anticus and peroneus longus muscles, and the plantar fascia. The dorsum of the foot is increased and prominent, the sole of the foot is shortened, and in severe cases the heel and balls of the little and great toes only rest upon the ground in walking. As a primary affection it is rare, though the writer has met a case, it being usually associated with calcaneus; as such it usually depends upon contraction of the plantar fascia. As a complication of congenital equino-varus, it sometimes persists after the complete correction of the equinus and varus by mechanical extension. The walk in congenital cases is not much affected, but may become painful and even impossible from callosities and ulcerations the result of pressure. In others, described as "painful cavus," tarsalgia may result from over-use, independently of the pressure symptoms. The anatomic changes, except in severe cases, are not, as a rule, marked. The plantar fascia is contracted, the dorsal ligaments are elongated.



FIG. 62c.—TALIPES CAVUS.

The diagnosis is easy, and it has only to be distinguished from the compound form, calcaneo-cavus, where the balls of the toes are elevated above the

level of the heel. If the balls of the toes are on the same horizontal plane as the heel, the condition is called talipes arcuatus; but if they are below the level of the heel, it is designated talipes plantaris. The prognosis in the congenital cases is excellent, and even in the acquired forms the deformity may usually be much relieved by appropriate measures.

Pes Planus.

Synonyms.—*English*, Splay-foot; Spurious Valgus. *German*, Plattfuss. *French*, Pied-plat. *Italian*, Piede spianato. *Spanish*, Pié plano.

Splay-foot, the direct opposite of pes cavus, consists essentially of a flattening of the plantar arch without abduction of the anterior part of the sole. The latter element differentiates it from talipes valgus.



FIG. 621.—TALIPES PLANUS
OR PES PLANUS.

It may be either congenital or acquired. It is hereditary in, and characteristic of, certain races, particularly the Jews and negroes.

The anatomic changes consist in relaxation of the ligaments which support the plantar arch, allowing the tarsal bones to rest upon the ground.

The entire sole is applied to the ground in walking, and progression loses its normal elasticity. Tarsalgia from abnormal pressure is a frequent symptom. It never reaches a degree beyond the first stage of valgus.

The normal condition of the bones and joints, especially the astragalo-scapoid joint, serves to distinguish it from talipes valgus.

Non-deforming Club-foot.

Under this head Shaffer described a variety of equinus which hitherto had escaped the observation of surgeons and writers on deformity.

“In non-deforming club-foot,” he writes, “all the conditions found in certain forms of talipes exist, with the exception of the exaggerated deformity. That is, there is a loss of normal relation between the articulation at the ankle and the muscles which act upon it, involving also in many instances the tarsus, producing a condition which prevents flexion at the ankle-joint, and modified mobility, with slight deformity at the tarsal, metatarsal, and phalangeal articulations. With this state of affairs we find as a result, varying with the conditions

present, actual disability, pain, sometimes very severe, in various parts of the foot, ankle, leg, and even reflected to the lumbar region, and tender and inflamed articular surfaces, especially at the junction of the first metatarsal bone with its phalanx." It may occur at any age, but occurs most frequently among young and rapidly growing females, and is often associated with true rotary lateral curvature of the spine.

The diagnosis is simplified by a previous hysteric history, but is in all cases difficult and demands unusual caution.

Non-deforming club-foot may result from five different causes: "(1) non-deforming club-foot seen after poliomyelitis anterior; (2) non-deforming club-foot which follows simple and uncomplicated malposition, habit, etc.; (3) non-deforming club-foot produced by traumatisms, sprains, etc.; (4) non-deforming



FIG. 622.—NON-DEFORMING CLUB-FOOT.



FIG. 623.—NON-DEFORMING CLUB-FOOT.

club-foot found after infectious diseases of childhood, especially diphtheria and scarlet fever; (5) non-deforming club-foot due, as I believe, to some remote trophic disturbance and seen quite frequently coexisting with true lateral curvature." The diagnosis is made by finding that the foot cannot be flexed beyond a right angle. The prognosis under appropriate treatment is excellent and recovery prompt.

Neuromimesis of Club-foot.

The mimicry of club-foot, the so-called *hysteric club-foot*, is more familiar to neurologists than to orthopedic surgeons, but the chapter would be incomplete without some reference to this interesting deformity. It occurs most frequently in young females about puberty, and consists of a chronic spasmodic

contraction of some of the muscles of the leg, particularly the calf muscles, and is usually associated with some other hysteric element.

TREATMENT OF SPECIAL VARIETIES.

Treatment of Varus.

The treatment of pes varus forming a part of the congenital variety, equinovarus, can best be considered under the compound variety. There remains the treatment of the acquired and paralytic varus. The eversion of the anterior part of the foot in this deformity may be accomplished either by mechanical measures or by operative procedures. If the muscles are contracted, this can best be done by means of



FIG. 624.—JUDSON'S VARUS WALKING-BRACE.

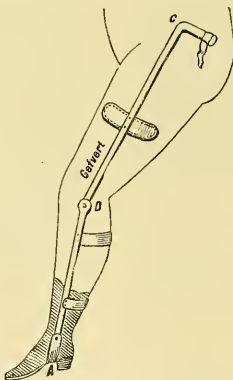


FIG. 625.—BRACE FOR INTOEING.

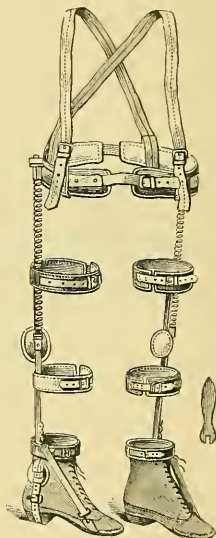


FIG. 626.—GREGORY DOYLE'S APPARATUS FOR RESIDUAL VARUS.

Shaffer's varus shoe, the mechanical construction and action of which can best be given under the compound form. In the paralytic variety the elastic traction appliance will be found most efficient. In some cases section of the plantar fascia and tenotomy of the tibialis anticus and posticus will be necessary. In dividing the plantar fascia in these paralytic cases it is best to make but a moderate division at first, and repeat the operation subsequently, lest the varus be converted into a valgus deformity. In severe cases it may be necessary to resort to *brisement forcé*, but tarsectomies and tarsotomies are seldom or never necessary in these cases. In this connection the

treatment of varus, which remains after the correction of compound varieties in completely corrected cases, the so-called "residual varus," may be referred to. This may be corrected by the forcible correction of the deformity under an anesthetic, with or without tenotomy as the case may require. Mild cases may be overcome by mechanical appliances alone, of which Doyle's apparatus will be found the most efficient. This consists of a spiral spring attached to the outer part of the outer aspect of an ankle support and attached at its upper extremity to a pelvic band. By means of a key any amount of everting force may be given to the spring. As a therapeutic measure skates for both out-of-doors and parlor use may be employed with great benefit.

Treatment of Acquired Valgus.

The treatment of pes valgus acquisitus varies with its cause and degree. Any diathetic tendency must be corrected by appropriate measures. The mild varieties yield readily by electricity to the affected muscles, massage, and removal of the exciting cause, with properly fitted metallic sole-plate. The massage should be especially applied to improving the condition of the peroneal group of muscles upon the outer aspect of the calf. These should be daily rubbed, preferably by a trained *masseur*, and electricity should be applied over the position of the peroneal muscles and to the musculo-cutaneous branch of the external popliteal nerve which supplies these muscles. Exercises directed to the development of the size and strength of these muscles are also advisable. Dancing, skipping rope, walking on the toes, and similar exercises are valuable. The following exercises are to be recommended:

I. This exercise consists in standing with the heels together and feet turned out, then slowly rising on tiptoe, separating the heels, and again slowly lowering them. This should be repeated twenty times, night and morning.

II. This exercise consists in standing with the heels together and the feet turned out, and raising the front part of the right foot and raising the inner side and gradually approaching the left part. Repeat twenty times. The same exercise is then performed with the left foot.

III. This consists in sitting with the heels together and the toes turned in. Both feet are then separated in front, and brought together. Repeat twenty times.

Shoes.—Certain requirements should be met in shoes to assist in preventing the occurrence of flat-foot. The inner side of the shoe should be straight to conform to the normal line of Meyer, the long axis of the great toe carried backward should pass through the center of the heel. There should be enough

room in the front to allow the foot to spread out flat and to permit the toes to extend individually. The heel should not be high. The upper should fit loosely enough to permit the action of the dorsum of the foot and toes. The deformities produced by unsuitable shoes have already been referred to in the first part of the book, and while a properly fitting shoe may be recommended by the orthopedic surgeon, few persons today can be induced to wear a shoe which is properly constructed if it is not elegant in appearance. The principal danger to be avoided is the cramping of the foot in front, the too great elevation of the heel, and the lack of support to the inner side of the arch.

The Thomas treatment, which consists in elevating the inner side of the sole and heel, is useful in the early and acute stages, but as the principle upon which it is based is erroneous it should be discarded as soon as possible.

Mechanical Treatment.—To support the arch numerous devices have been recommended—pads of leather, felt, rubber, and other material attached to the inner or outer side of the sole, steel bars, springs, etc., added to specially constructed shoes, etc. The writer has attained the best results with the improved plate spring of Roberts. It consists of a tempered steel plantar spring, so constructed as to supply an artificial arch which prevents further displacement of the astragalus and scaphoid and supports the foot as a whole. It is best made over a modeled cast of the foot. A similar spring without the elevated flanges is recommended by Hoffa, who says one cannot make the corrected cast entirely normal in the arch, as the patient cannot stand the pressure.

This corresponds to the writer's experience. The correction should be gradually made and the plate be changed to suit the improved shape of the foot. The author marks on the cast the desired shape of the plate and corrects the cast so as to apply the pressure to the desired point.

The making of the casts is an important procedure. Plaster-of-Paris is mixed with water to about the consistency of thick cream. This is poured into a pasteboard box or greased tin can of sufficiently large size to hold the foot, which after being greased with vaselin is placed in the plaster and allowed to remain in a correct position without undue pressure until the plaster has hardened. This mold is then anointed with vaselin, or a mixture of sweet oil, castile soap, and water, and is filled with soft plaster, an exact reproduction of the foot being obtained in this manner. The modeling of this cast requires skill and experience, since a spring made from such a cast would

not fit the foot comfortably unless it were modeled to an exact counterpart of the foot.

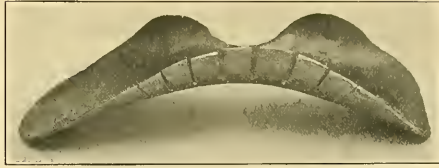


FIG. 627.—AUTHOR'S SPRING FOR FLAT-FOOT.

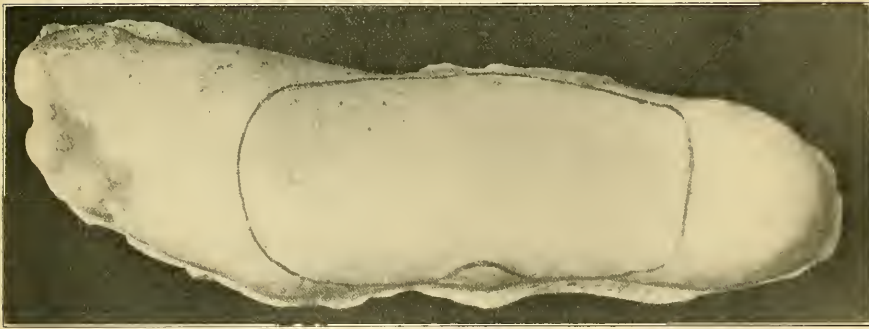


FIG. 628.—CAST OF FOOT WITH OUTLINE OF SPRING.



FIG. 629.—AUTHOR'S SPRING, FINISHED WITH LEATHER.

In most cases the cast must be modeled to provide support for the displaced head of the calcaneum. In others the pronation of the entire foot inward

must be supported, and if there is any tendency to breaking down of the anterior arch support must be furnished to the front part of the foot. The plate should not extend as far as the ball of the great toe and should not be sloped to such a degree that the foot is constantly sliding outward. In most instances it should be made straighter on the inside, and the level of the heel and the front part of the plate must be adjusted to suit the "tread" of the foot, and in some cases to suit the "tread" of the shoe. When fitted to the shoes, the springs should give comfort; and if they do not do so, something is wrong with the manufacture of the plates.

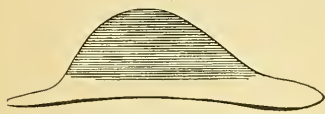


FIG. 630.—AUTHOR'S HARD-RUBBER FLAT-FOOT SPRING.

Some patients cannot wear plates from the beginning, and in these cases it is necessary to use pads of felt, specially cut, pads of soft rubber, or small flat leather or felt insoles. Hair insoles are sometimes of service in producing a soft surface for painful feet, and rubber heels and rubber soles often add greatly to the comfort of persons suffering from flat-foot.

The springs may be made of tempered steel, German silver, or phosphor-bronze. A similarly shaped support may be made of celluloid, but the flanges are omitted. These celluloid supports are cut from sheet pyrolin, bound securely to the corrected cast with rubber tubing, softened in boiling water until they assume the exact shape of the cast,

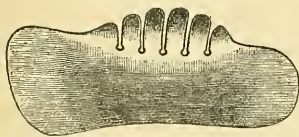


FIG. 631.—ROBERTS' FLAT-FOOT SPRING, UNDER SURFACE.



FIG. 632.—ROBERTS' FLAT-FOOT SPRING, UPPER SURFACE.

when they are removed, trimmed, and smoothed to a neat finish with proper tools.

In severe cases, after the restoration of the arch by operative measures, the spring may with advantage be supplemented by an ankle support—two lateral steel uprights connected with a band extending about the calf, and an internal oval ankle-pad over the mediotarsal articulation.

As a symptomatic condition in osteitis of the tarsus and ankle-joint disease,

the valgus generally yields to the treatment employed for the primary osseous or articular lesion.

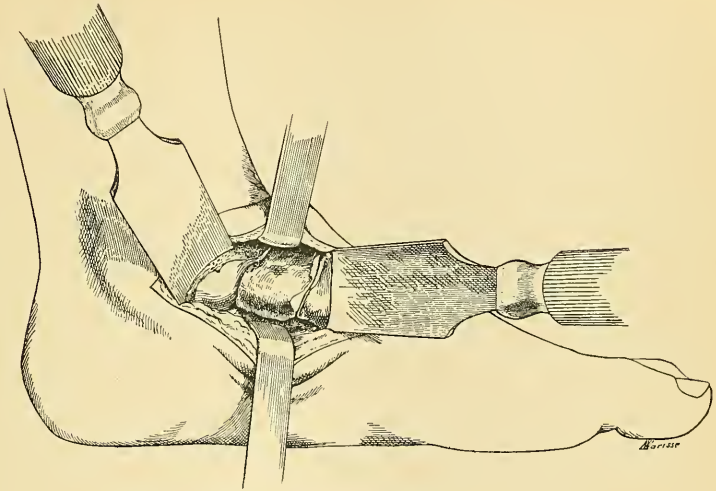


FIG. 633.—OGSTON'S CUNEIFORM TARSECTOMY FOR FLAT-FOOT.

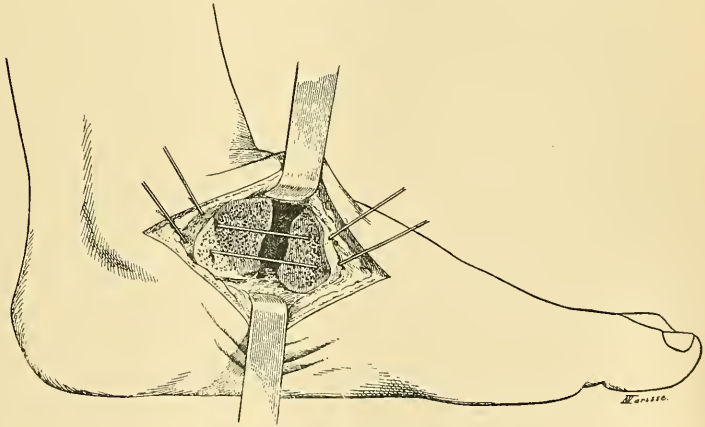


FIG. 634.—SAME, SHOWING SUTURES.

Operative Treatment.—In severe cases, before resorting to extreme operative measures, all contracted tendons should be divided. Those most

frequently requiring division will be the tendo Achillis, peronei, and extensor longus digitorum, and they are best divided in two stages—the peronei and extensor longus digitorum first, to correct the valgus, and the tendo Achillis subsequently, to correct the equinus, which in severe cases is present. Failing in the worst cases to restore the arch by such means, accompanied with manual force, *brisement forcé*, with either a Thomas or Bradford wrench, should be attempted, or, what I have found best, is the use of a Gefvert screw-plate. This consists of two star-shaped plates attached together with a triple screw; one plate is arched to fit the sole of the foot. The appliance is bandaged to the sole of the foot, and by means of the screw any amount of force can be applied to correct the deformity. After the correction a pad should be placed against the arch of the foot and the foot be fixed in a position of extreme varus and held in a plaster-of-Paris dressing for two weeks. As a last resort, Ogston's operation should be resorted to, or, if much ankylosis be present, a regular tarsectomy—*i. e.*, removing a wedge-shaped piece of the tarsus from the inner side of the tarsus without reference to the bones or portions of bones removed—should be performed, and the restoration of the foot be completed. A more satisfactory operation is that of Reverdin, which consists in removing a portion of the calcaneum and scaphoid and suturing them together, thus producing an arthrodesis.

Gleich's Operation.—The operation is performed as follows: An oblique incision is made through the calcaneum. He first performs a tenotomy of the tendo Achillis, then exposes the calcaneum by a transverse incision similar to that of the Pirogoff amputation. He then saws through the calcaneum obliquely from below and anteriorly in an upward and posterior direction. He then pushes the posterior part of the calcaneum, which carries the tuberosity downward and forward, in this manner reproducing the angle which the axis of the calcaneum forms with the ground and which has been lost in flat-foot. The results reported were perfectly satisfactory. The same result would be attained if a wedge with the base downward were cut out of the calcaneum and the posterior part of the foot were pushed forward.

These severe operations should be resorted to only when milder measures, after due trial, have failed; for comparative relief will, in the great majority of cases, be obtained by the milder remedies in about six or eight weeks, whereas several months are required after any cutting operation upon the tarsal bones before the foot may with impunity be freely exercised.

Treatment of Paralytic Valgus.

The treatment of this variety requires the same attention to the employment of massage, electricity, and the use of plantar springs and other mechanical appliances as do the other forms of flat-foot. The use of electricity in these cases is particularly serviceable, and the rules laid down for its application under the general head of treatment should be observed. It is of the greatest advantage in the infantile paralysis cases to prevent fatty degeneration of the muscles and to improve the condition of the skin. In these cases marked eversion of the foot upon the leg occurs from the growth of the foot, as pointed out before, and the tension upon the peronei tendons. This condition may be overcome in part or entirely by the division of these tendons after the rules previously given under the general head of tenotomy.

After an operation of this character over-correction is not so essential as in ordinary tenotomy performed for contracted tendons. Two weeks should elapse before the foot may with safety be used, and at first only in moderation. The greater number of these cases also require a high sole or patten to equalize the length of the limbs, since the paralysis has usually diminished the growth of the limb in length as well as in size. Elastic webbing-straps are often necessary to maintain the foot in a good position. These pass from the inner side of the front part of the shoe to the inner or anterior part of the band which encircles the leg below the knee. It is in these forms of club-foot that the elastic traction apparatus are most efficient.

Treatment of Equinus.

The treatment of the congenital equinus forming a part of the congenital equino-varus will be given under the compound variety. The contraction of the heel in talipes equinus may be overcome either by mechanical or operative means according to the degree of deformity present. In the milder cases, if the foot can be prevented by light mechanical appliances from turning to either side, the weight of the body in walking will overcome the deformity in many instances. A very useful apparatus is Shaffer's appliance for correcting equinus. This consists of two steel uprights extending from the upper part of the tibia to the ankle-joint, and attached to it a heel-cup and sole to hold the foot, the heel being held in its place by means of a strap of webbing, a bandage, or similar material passed over the instep. The efficiency of this apparatus has been increased by dividing the sole of the brace opposite Chopart's joint, this anterior portion being worked by an extension-bar passing beneath the heel-cup. The

apparatus is applied extended to an angle corresponding to the angle of deformity; the heel is secured by means of two straps, one passing over the instep, as before described, and the other passing around the heel and forward to be attached to either side of the sole-plate. By means of a key at the ankle-joint the foot-piece is flexed upon the upright, and by means of the extension-bar the anterior portion of the sole is thrown forward, the os calcis is dragged upon by the strap passing over the heel, and the tendo Achillis is thus thoroughly stretched. This stretching is repeated several times at each sitting, the pressure being not continuous, but a momentary overstretching followed by relaxation. By this means the tendo Achillis may be extended until the deformity is slightly over-corrected, when the apparatus is substituted by a retention shoe with a stop-joint at the ankle to keep the foot in the corrected position. By these mechanical measures the writer has corrected a number of infantile cases of severe equinus.

In the severer grades, in adults and where the time for treatment is limited, tenotomy of the tendo Achillis will be found the most satisfactory plan of treatment. The operation itself has already been given under the general subject of tenotomy. After the section of the tendon the foot should be placed in a slightly over-corrected position; and retained by means of a plaster bandage. Two weeks after the operation the foot should be placed in a retention walking-shoe with a stop-joint at the ankle to keep the foot in the corrected position.

The after-treatment should be carefully carried out, and has already been given under the general subject of tenotomy. If the deformity has resulted from paralysis of the anterior group of muscles, in addition to these measures electricity and massage should be applied to the whole leg, and elastic straps should be added from the anterior portion of the shoe to the upper part of the brace to supplement the paralyzed or weakened muscles. In this connection the treatment of "compensatory equinus" deserves notice, since this usually results from an attempt to equalize the length of the shortened limb by an affected or acquired equinus. The simple use of a cork patten will in the majority of cases overcome the difficulty. If, however, the foot has remained in this position long enough for the bones, tendons, and ligaments to have become altered, the mechanical and operative measures before referred to will become necessary. In "non-deforming club-foot," which in many cases is simply an incomplete equinus, the stretching of the tendo Achillis by means of Shaffer's appliance for correcting equinus will readily overcome the difficulty. In many of these cases relief is obtained after one or two stretchings of the contracted tendon.

If, however, these measures should fail to bring the foot into an over-corrected position, tenotomy should be resorted to.

Treatment of Calcaneus.

As a congenital affection the treatment of calcaneus seldom requires more than daily manipulation and extension of the foot to overcome the deformity. In the severest cases tenotomy of the tibialis anticus, peroneus tertius, and extensor longus digitorum may be required. The corrected foot may then be retained by a simple walking-shoe with a fixed joint to prevent flexion beyond a right angle.

Judson has advocated a brace of this kind consisting of an upright and foot-piece, the joint between the two so constructed that the foot-piece falls but cannot be raised beyond a right angle with the upright. Attached to the foot and leg in standing and walking, the foot will remain at right angles with the leg.

The treatment of the paralytic cases from anterior poliomyelitis can best be accomplished by means of retention apparatus, with an elastic strap to limit flexion beyond a right angle. Operative interference in these cases is indicated in the severer forms, and consists of shortening of the tendo Achillis, transplantation of the peroneal tendon, and arthrodesis.

The best operation consists in dividing the tendon after the oblique method of Reeves, or with the Z-formed incision of Anderson, sliding the cut ends past each other until the desired shortening is attained and stitching them very firmly together with chromicized catgut, including the skin and tendon. The results of this operation are generally satisfactory; not only is the deformity corrected but the foot frequently resumes the growth interrupted by the faulty position. It is in this condition that transplantation of tendons has proved efficient. At the same time the tendo Achillis has been shortened. The peroneus longus tendon and a portion of the flexor longus digitorum should be sutured in between the cut ends of the tendo Achillis. In a case of marked pes calcaneum Hoffa performed Gleich's flat-foot operation in a reversed manner, cutting the tuberosity of the calcaneum through obliquely and pushing it backward and upward, at the same time excising a piece of the tendo Achillis. The result was excellent.

Arthrodesis is also valuable and Whitman* has devised an operation which combines astragalectomy, tendon transplantation, and arthrodesis, and which

* "Am. Jour. Med. Sciences," Nov., 1901.

is invaluable in inveterate or complicated cases. The astragalus is removed in the usual manner except that the peroneal tendons are divided. The articular surfaces of bone are denuded and the peronei tendons, if active, are attached through a hole into the os calcis just below the insertion of the tendo Achillis. The foot is displaced forward, drainage is not provided, and the corrected position is maintained by means of a plaster cast. When the peroneal tendons are displaced forward from behind the external malleolus, this tendency may be corrected by a bandage or brace, or if severe it should be lengthened and sutured into the groove from which it has slipped.

Treatment of Cavus.

The treatment of the milder forms may be accomplished by extension with an equinus shoe, particularly the pattern of Roberts, by which powerful stretching force can be applied to the plantar fascia. The severe forms will demand aponeurotomy of the plantar fascia, and the division should at first be moderate and repeated lest valgus result. The after-treatment will consist in the use of an extension night brace to prevent relapse.

Treatment of Planus.

The plan of treatment advised for the milder forms of valgus *acquisitus* or flat-foot may with advantage be employed in the correction of *pes planus*. Friction, massage, and electricity to the peroneal muscles, and exercises calculated to improve the power and tension of these and the plantar muscles, should be employed. In addition to these measures a well-fitting plantar spring should be used, changing its height from time to time as the elevation of the arch demands. Systematic exercises are to be employed, and dancing is to be recommended for this affection, particularly in young growing girls.

Treatment of Neuromimesis.

The treatment, as in other neuromimeses, should be conducted with the same care and attention to detail as if the patient had a genuine deformity, directing particular attention simultaneously to the nervous element present, and to the improvement of the general *morale* of the individual. Tenotomy is seldom required; but after other means have failed it may become necessary, and may be undertaken with great confidence.

Treatment of Equino-varus.

The treatment of this variety of club-foot can best be considered under two heads—the treatment of the congenital variety and that of the acquired form. The treatment will necessarily vary according to the patient's age and the degree of deformity present; but the process of rectification is best divided into two stages—first correcting the varus and afterward correcting the equinus. The correction of the varus deformity will include manipulation, massage and electricity, retentive dressings, extension and fixation, and tenotomy combined with extension and fixation. In the severer cases, to these must be added *brisement forcé*, tarsotomy, and tarsectomy.

Manipulation and Massage.—The milder cases, if treated from birth, will often yield to these simple measures alone, and the writer can refer to many mild cases successfully treated in this manner. It is essential in treating cases in this manner to instruct the nurse or mother personally how to grasp the foot and how to apply the force. With one hand the heel should be firmly grasped, while the other firmly holds the anterior part of the child's foot in a correct position. Here it should be held for a few moments, and this should be repeated as many times as possible through the day. In addition to this correction the muscles of the calf and sole of the foot should be manipulated, and the electric current should be applied to the affected muscles and entire limb, according to the method already described.

Retentive Dressings.—The addition of some form of retentive apparatus enhances materially the prospect of a cure. For this purpose numerous materials have been applied, manufactured from tin, leather, pasteboard, stiffened felt, and other materials, held in position by bandaging. The best material, however, for this purpose is the plaster-of-Paris bandage. In applying this dressing either for correction or retention after correction of the deformity, the technic is important. All the bony prominences must be protected by a padding of cotton, over which a flannel roller should be firmly and smoothly applied. In applying this, advantage may be taken of the direction of the turns in correcting the deformity. Fixing the bandage above the ankle by an oblique and circular turn, the roller should run diagonally across the instep to the ball of the great toe, across the sole of the foot to the little toe, to the outer side of the leg above the ankle, making firm traction before proceeding further, so as to evert and elevate the outer border of the foot. This turn can then be repeated one-third higher up, until the entire foot and leg are covered, after which the knee, bent at a right angle, and the thigh, are covered in.

Another method of applying the roller consists in running a turn around the flexed knee down the leg, around the foot and back to the starting-point, finally covering in this turn with circular turns.

When sufficient turns have been applied, the foot and limb should be held firmly in the corrected position while the plaster is setting, applying the palm of the hand to the sole of the foot, and avoiding undue pressure of the individual fingers lest the indentations in the soft plaster produce sloughs.

In very young children the upper part of the dressing may be protected by a coating of shellac or liquid glass to prevent the soiling of the dressing by discharges.

Extension and Fixation.—For the purpose of extension and fixation, one of the many modifications of Scarpa's shoe offers the best mechanical means. The best, however, at the present time is Taylor's ankle support and Shaffer's and Roberts' modification of this. Taylor's appliance consists of a flat steel sole-plate, made from the outline of the plantar surface of the foot, and a steel upright on the inner border extending at right angles to the sole-plate and jointed opposite the ankle. The foot is firmly fixed to the sole-plate by straps of webbing; the foot is then firmly everted, and the upright is then brought into position at the side of the leg, and retained there by a buckle and strap. This appliance can be readily and easily constructed, and offers an efficient method for the correction of the varus. It has also been employed to correct the equinus, but for this purpose the additional application of adhesive plaster to the leg is necessary. Shaffer's appliance for the correction of varus is a decided improvement over this, and offers the best mechanical means for correcting this deformity. The instrument consists of a sole-plate made from the outline of the foot, and divided opposite the mediotarsal joint into two parts, attached at the outer border by a hinge and manipulated by means of a screw. To this sole-plate is attached a steel trough, fitted to the inner side of the leg and divided obliquely opposite the ankle-joint by an oblique hinge, the direction of which is such as to allow pressure, exerted by means of a screw, to operate upon the varus deformity. The mechanism of the divided portion of the sole-plate has been improved by Roberts by substituting for the extension-bar employed by Shaffer a triple-thread screw. This apparatus is applied to the foot in the direction of an angle corresponding to the angle of deformity. The foot is then forced into a corrected position, which does not produce pain, and on several occasions during the day the contracted tissues are momentarily overstretched, held there for a few moments, and then relaxed. In this manner

little by little is daily gained, until in time severe deformities are corrected. The writer would express his satisfaction in the use of this apparatus, and report several severe congenital cases in private practice cured by its use. The mechanical treatment of club-foot is not suitable for public practice.

Tenotomy Combined with Extension and Fixation.—A combination of tenotomy with extension and fixation offers one of the quickest and best and surest methods of correcting these deformities. The tendons which will require division to correct the varus are the tibialis anticus, tibialis posticus, and plantar fascia, and in some cases the division of astragalo-scapoid and calcaneo-cuboid ligaments. The part should at once be strongly manipulated until the over-corrected position remains with the application of but little force. It is then retained in this over-corrected position by means of a well-applied plaster-of-Paris bandage, or by means of other retentive apparatus.

The severer forms will require, in addition to these measures, the use of powerful correcting force and some of the cutting operations upon the tarsus.

Brisement forcé should be applied by one of the wrenches or apparatus already described in Part I, in such a manner as to force the foot into a varus position.

Tarsectomy and tarsotomy are necessary only in the severest forms of club-foot, and since they expose the patient to considerable risk, their field of application should be limited. The operation which would be called for in these cases would be one of the two operations before given under the general head of tarsectomy and tarsotomy, selecting the proper operation according to the severity of the individual case. If the over-correction has been thoroughly accomplished, the danger of relapse will be greatly diminished, but in all cases it is necessary to carry out the after-treatment strictly; and in the majority of cases a retention walking-shoe is advisable for at least one year.

Treatment of Equinus.

The second division of the treatment of equino-varus, the correction of the equinus, will require resort to all the measures before given except the *brisement forcé*. In the milder cases strong flexion of the foot upon the leg, many times repeated, will in many instances overcome the deformity. In this, as in other deformities, what has been gained by these manual means may be retained by the use of fixation apparatus of different varieties. In the severer cases tenotomy of the tendo Achillis, combined with extension and fixation,

should be resorted to. The technic of this has already been given under the treatment of equinus proper.

Treatment of Acquired Equino-varus.

Treatment of acquired equino-varus will require, in addition to the measures already given, a more frequent resort to rubber muscles to supplement the action of the weakened or paralyzed muscles. Electricity will be valuable in the paralytic forms, and in the severe grades astragalectomy has been resorted to with success. Transplantation of the whole or part of the tibialis anticus tendon to the outer side of the foot after Lange's method, with perhaps arthrodesis of the astragalo-scaphoid articulation in a corrected position, will be found of service.

Treatment of Equino-valgus.

The treatment of this compound variety will include the treatment prescribed for the two forms of which it is a compound. In the congenital forms and in the severer grades tenotomy will become necessary.

Treatment of Calcaneo-varus and Valgus.

The treatment of these compound varieties has already been given in sufficient detail in the individual forms of which these are the compounds. Muscle transplantations, arthrodesis, and tendon-shortening are valuable measures in the severe forms. In the paralytic forms this will consist of transplantation of the tendons of the extensor longus hallucis into the scaphoid by the periosteal method of Lange, which will be found to be a valuable procedure, especially if combined with arthrodesis of the astragalo-scaphoid articulation.

CHAPTER XXVIII.

OTHER AFFECTIONS OF THE FEET.

Metatarsalgia.—Attention was first called to this painful affection of the feet a quarter of a century ago by Thomas G. Morton, from whom it is sometimes called “Morton’s toe.” Attention was directed to the painful affection caused by pressure upon the fourth plantar digital nerves, but since that time the term has been extended to include pressure upon other nerves. It has



FIG. 635.—SKIAGRAPH SHOWING METATARSALGIA FROM SEVERE DISTORTION OF TOES.

since been thoroughly described by T. S. K. Morton. The disease has not been observed until after adolescence, and women appear to be more predisposed to it than men. The exciting cause is usually excessive or unusual exercise on the foot while wearing narrow, tight, or new shoes, or from changing from a firm-soled shoe to one permitting greater motion. The pressure pro-

duces a neuralgic condition which may become neuritis. The foot is blue and cold, and has a tendency to sweat profusely. The pain is acute, and the "imperative necessity of removing the shoe regardless of surroundings when a paroxysm comes on" is regarded by Morton as a pathognomonic symptom of the disease. Upon examination a tender point may be detected by gentle pressure with the finger between the fourth and fifth metatarsal bones. The anatomic relations of the fourth metatarsal joint are such that pressure is most readily caused at this point. A hook-like exostosis is often found projecting



FIG. 636.—SKIAGRAPH SHOWING METATARSALGIA FROM DISEASE OF FOURTH METATARSO-PHALANGEAL JOINT.

downward from the fourth metatarsal bone. The pressure theory has been doubted by some, and Halstead has disputed the relationship of the nerves to the heads of the metatarsal bones. The French school refers this condition to inflammatory lesions, fractures, callosities, etc. Many orthopedic surgeons attribute the condition to breaking-down of the anterior arch of the foot. I am convinced from the examination of a large number of cases that the enlargement and pressure of the fourth metatarsal bone is responsible for the pain in many of these cases. In others it is due to fracture of the tarsal, or particularly the base of the fifth metatarsal bone. Metatarsalgia is frequently met

in the distal extremities of the other metatarsal bones, from a breaking-down of the anteroposterior arch. Comparatively few persons suffer any inconvenience from this deformity; but in a limited number of cases distressing symptoms develop, such as irregular attacks of pain, accompanied by the formation of a painful callus in the middle of the ball. This affection is simpler, more amenable to treatment than, and should not be confounded with, the condition described by Morton. A glass table with an inclined mirror beneath it is valuable in ascertaining exactly where the pressure falls. A skiagraph is of some importance in determining the condition of the metatarsal bone. If the bone is not greatly deformed, the disease may frequently be cured without resort to operation. But if the bone is enlarged, the operation becomes necessary.

The treatment of this affection consists in the application of a narrow flannel bandage about the ball of the foot, and the use of proper shoes, the principle of which includes a broad rigid sole. Special shoes are sometimes made for these patients. They are made with cavities in the sole and with filled-up irregularities to better adapt it to the deformity of the foot. If the pain be due to a breaking-down of the anteroposterior arch, a small felt pad, so applied as to restore the arch, and secured by strips of adhesive plaster and a gauze roller bandage, would relieve the symptom. Insoles of metal, or preferably of leather, with an oval elevated pad under the anterior arch will be found curative in mild cases. The separation of the toes, and particularly the fourth, from the others by means of cotton or by wrapping the toes with adhesive plaster will sometimes relieve. Persons of rheumatic or gouty diathesis require medical treatment.

Operative treatment: In severe cases where there is enlargement of the articulation no treatment except excision of the metatarso-phalangeal articulation will be curative. In most cases it is best to amputate the toe also, as there is no particular advantage in leaving this member, and the wound heals



FIG. 637.—SKIAGRAPH SHOWING DISLOCATION OF FIFTH METATARSO-PHALANGEAL JOINT.

more quickly. The nerve may be examined at the time of operation, but removal of a piece of the nerve is not recommended for fear of progressive neuritis.

Pronation.—The condition spoken of as “pronated foot” by Lovett, Dane, and others frequently gives rise to pain. This condition consists in a rolling in of the inner side of the foot from the superincumbent weight. The fault lies with the ankle rather than with the arch. The first symptom is a weariness and discomfort upon long standing, followed later by pain, with a flushed and hot stinging sensation in the skin associated with sensitive spots.



FIG. 638.—SKIAGRAPH SHOWING CROWDING OF FOURTH METATARSAL BONE, LEFT FOOT, FROM FRACTURE OF BASE OF FIFTH METATARSAL.

The pain sometimes radiates to the leg and thigh; and the patient sooner or later loses elasticity of gait and assumes a clumsy walk, with the feet everted. This affection is usually due to the use of improper shoes. It may or may not be associated with flat-foot.

The treatment for this affection is the same as for flat-foot, in addition to which greater stress should be laid upon the development of the weakened muscles.

Sprains.—Sprains of the foot, and particularly of the ankle-joint, frequently give rise to pain long after the acute symptoms have disappeared. This

is most frequently the case after Pott's fracture of the lower third of the fibula, which is always associated with rupture of the internal lateral ligament. This gives rise to a flat or pronated foot. Sprains produced by a crushing force not infrequently lead to flat-foot.

Viewing sprains and sprain fractures from the standpoint of the orthopedic surgeon, surgeons should attempt to restore or maintain the plantar arch during convalescence from these injuries. Late ecchymoses should not be disregarded



FIG. 639.—SKIAGRAPH SHOWING METATARSALGIA FROM CROWDING OF FOURTH METATARSAL, BEFORE OPERATION.

as indicating sprain fractures of the tarsal bones, and the plantar arch should be restored as soon as possible after the injury.

The treatment of these sprains consists in the restoration of the arch and the treatment of flat-foot as already described, in addition to which great benefit may be derived from the application of rubber adhesive strips crossed over the ankle-joint and applied in such a manner as to support the weakest part. Pads may be incorporated, and the application of a small felt pad directly to the skin, held in place by strips of adhesive plaster and covered with a well-fitting muslin bandage, will often relieve. Baking in a hot-air apparatus and massage should not be neglected.

Strain of the tendo Achillis is sometimes observed where the foot has been subjected to unusual or severe efforts. A sensitive point will be found upon pressure at the origin of the tendon or midway between its origin and insertion. This condition resembles rider's strain. The treatment consists in strapping the part with embrocated layers of adhesive plaster, with rest, to be followed later by massage or the use of an embrocation. Strain and rupture of the plantaris tendon and muscles sometimes occur, a condition which has sometimes been spoken of as "tennis leg." The pain is referred to the back of the leg and upper



FIG. 640.—SAME AS FIG. 639, AFTER OPERATION.

part of the calf and is increased upon flexion of the foot. It follows strain at lawn tennis and may be relieved by fixing the foot in an extended position.

Hammer-toe.—The term hammer-toe is used to describe a condition of extension of the first phalanx, and flexion of the others. This may affect one or all of the toes. If the great toe be affected, the unguinal phalanx is alone flexed. The condition occurs both as a congenital and as an acquired affection. The former case is usually the result of some infantile nervous disease, and the acquired variety is usually the result of wearing shoes that are too short, as a result of traumatism, or as a sequel of some nervous disease. In attempting

to walk, the toes become more flexed and painful; and painful corns are formed over the interphalangeal joints. Some writers make a distinction between the hammer-toe and the claw-shaped toes met with in some cases of paralytic club-foot, but this does not seem to be necessary. Both the extensors and the flexors are found to be simultaneously contracted, and in some instances the phalanx fibers of the lateral ligament of the toes, together with the plantar fascia, are contracted.

The treatment in mild cases consists in the use of a plantar plate through which tapes are passed in such a manner as to hold the toes in their normal position. This is fitted into a shoe broad, square-toed, and with a low heel. In the severe cases tenotomy of the contracted tendons is necessary, and the writer performs the operation by making an open longitudinal incision on the plantar surface at the base of each toe, and dividing the flexor tendon on a grooved director. The extensor tendons are divided by the subcutaneous method. If the fibers of the lateral ligaments or the plantar fascia are contracted, these should be divided. In rare instances amputation of the toe or toes is necessary.

Claw-foot.—A condition similar to claw-hand is met in the foot, consisting of a contraction of all the toes, similar to that in hammer-toe. It is usually due to some lesion of the cord, and is sometimes associated with contracted foot. Palliative measures are of little value, and the best treatment consists in dividing both the flexor and extensor tendons on the plantar and dorsal surfaces of the foot. The extensors are best divided by subcutaneous section, but the flexors can be properly divided only by an open incision directly over the line of the flexor tendons beneath the toes. The tendons are lifted up on a grooved director and divided in sight. The incision should be sutured and the toes should be fixed in full extension with well-padded wooden splints on the dorsal and plantar surfaces, the whole being encased in a plaster-of-Paris cast.

Displacement of the Toes.—The small toes are sometimes displaced by being crowded together as the result of paralysis or the use of improperly fitting boots. One or more toes may be crowded down or up in such a manner as to make them painful and inflamed.

The treatment consists in maintaining the toe in the proper position by means of adhesive plaster, a roller bandage, or splints, and in severe cases amputation is sometimes necessary.

Individual toes will sometimes be found displaced in extension, in which

position they are held by the contracted tendon. The treatment of this condition consists in dividing the tendon subcutaneously and fixing it with a padded splint in a flexed position for two weeks.

Lateral Deviations of the Toes.—These include hallux valgus, hallux varus, hallux rigidus, and hallux metatarsus. The deformities of the toes which are included under the titles of hallux valgus, hallux varus, and hallux

rigidus are very rarely congenital, being usually acquired from mechanical causes or as the result of traumatism or disease of the bones and joints, gout, rheumatism, paralysis, and burns and scars.

Hallux Valgus.—In hallux valgus the great toe is drawn outward, and much pain is experienced in walking, usually at the metatarso-phalangeal articulation. Cramps are sometimes experienced in the foot, especially at night. The toes sweat freely, and corns and bunions add greatly to the discomfort. The deformity is usually due to improperly fitting shoes, the great toe being forced outward by the shortness of the shoes.

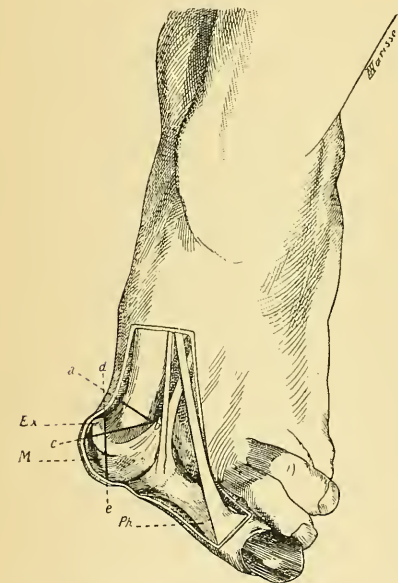


FIG. 641.—REVERDIN OPERATION FOR HALLUX VALGUS, SHOWING LINES OF SECTION (Berger and Banzet).

a, b, c, Cuneiform section; *d, e*, section of inner side of head of metatarsal; *Ex*, excised portion; *M*, bursa; *Ph*, phalanx.

ure, and prevent injury of the nail. In severe cases an operation is necessary to restore the toe to its proper position. This consists in an excision of the metatarso-phalangeal joint or osteotomy of the metatarsal bone, and in rare cases amputation of the toe.

Three operations have been devised for the relief of this condition. Wilson has recommended the removal of a piece of bone from the inner surface of the head of the metatarsal bone. The operation of Reverdin consists in the removal with a pair of heavy bone forceps of the proximal end of the first pha-

lanx, together with the removal of a cuneiform section with the base outward of the first metatarsal bone just back of its head. The operation is well shown in the illustrations (Figs. 641, 643). Another operation which may be recommended is that by Keller,* which he describes as follows:

"A longitudinal incision, two inches in length, is made along the inner side of the foot, exposing the first metatarso-phalangeal articulation. The skin and tissues over the head of the metatarsal bone are retracted; the joint is then opened and opposing articular ends are separated; the periosteal covering

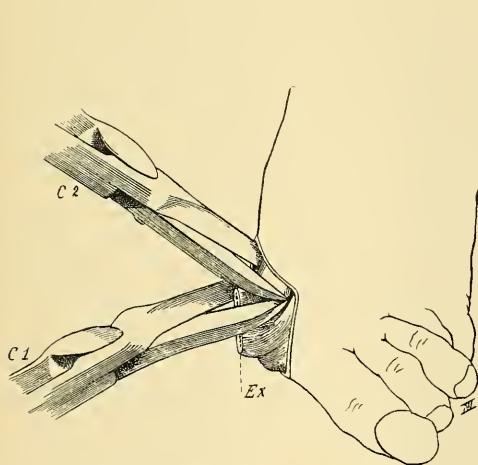


FIG. 642.—SAME, SHOWING TECHNIQUE (Berger and Banzet).

Ex, Inner side of head of metatarsal removed; *C1*, *C2*, removal of cuneiform section with cutting forceps.

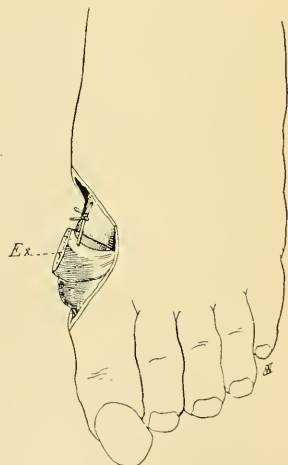


FIG. 643.—SAME, SHOWING OPERATION COMPLETED.

Ex, Surface from which section has been removed.

over the lateral enlargement and the adjoining part of bone are pushed back; and the exostosis, with about one-eighth of an inch of the bone, is removed by a rongeur forceps or, preferably, with a small saw. The tendon of the flexor longus hallucis is freed by blunt dissection, from the under surface of the base of the first phalanx, sufficiently to pass a Gigli saw around the bone; the periosteum is pushed back, disarticulation accomplished, and the articular head of the first phalanx is removed. Particular care should be taken throughout the operation to protect the periosteum from needless destruction, and an

* "N. Y. Med. Jour.," 1904, vol. 80, p. 741.

effort should be made to preserve enough of it to cover the exposed surface of the bone.

"A small gauze drain is inserted between the head of the metatarsal bone and the sawed end of the phalanx (this drain is removed after forty-eight hours). The wound is carefully sutured; the toe being maintained at normal extension by a narrow internal lateral splint. Passive motion is begun on the fifth day."

The advantages claimed for this operation are that the normal tripod of the foot is not disturbed, that the danger of ankylosis is comparatively slight, and that it can be employed even when the normal arch of the foot is high.

The operation which I prefer is an osteotomy through the first metatarsal bone just posterior to the head. An internal padded splint and a plaster dressing secure it in position for four weeks.

Hallux Varus.—The condition of hallux varus, or pigeon-toe, is exactly opposite to hallux valgus, in that the great toe is drawn away from its fellow and deviates toward the middle line of the body. The condition may be due to contraction of the short muscles of the great toe as a result of spasm. It is sometimes met in genu valgum, and sometimes it is a result of equino-varus; occasionally it is an acquired affection as a result of sprinting and other athletic sports, the foot being turned in, in order to get a firmer grasp upon the ground. It may be associated with macrodactyly, or it may be bifurcated, as reported by Clarke.

The treatment is very unsatisfactory, and the best appliance which the writer has met with is that of Barton Hopkins, which is applied to the heel of the shoe, by which means the foot is turned outward at every step. Mechanical appliances are not of much value, but an appliance may be made of leather bands and elastic webbing so constructed as to pass over the outer side of the foot, around the back of the calf, to the inner side of the knee, across the front of the thigh, and finally carried backward to be attached to a leather band about the waist. The spiral action of these elastic bands will have a tendency to evert the foot. Electricity and manipulation may be used, and in occasional cases tenotomy of the abductor hallucis may be performed. In severe forms of pigeon-toe the operation of Gibney, consisting of the removal of the tensor vagina femoris muscle by excision, may be undertaken. When bifurcated or supernumerary the inner one should be amputated.

The condition known as **hallux rigidus** consists of an ankylosis of the metatarso-phalangeal joint of the great toe. It is also known as "painful great toe," "hallux dolorosus," and "hallux flexus." The disease begins with

pain and swelling, followed by deformity, the proximal being flexed and the second phalanx extended, followed by ankylosis and atrophy. This is sometimes associated with flat-foot, but is usually the result of injury. It may be associated with contracted foot.

The treatment consists in the protection of the joint by splints, the restoration of the arch of the foot, and local applications of lead-water and laudanum or iodine, mercury, and belladonna ointment, to allay the inflammation. In severe cases excision of the joint is required to correct the deformity.

Hallux Metatarsus.—This affection, which is also known as “congenital hallux varus,” consists of a deviation of all the toes and metatarsal bones inward, the contraction of the great toe being most marked. The appearance is that of talipes varus, but the skiagraph shows the deformity to be a bending of the proximal shafts of the metatarsal bones. The treatment is not very satisfactory, but consists in tenotomies and osteotomies of the deformed structures.

Achillodynia.—The name achillodynia has been given by Albert to a painful affection, bilateral, occurring in the tendo Achillis. The pain appears after walking, and is relieved by resting either in the sitting or recumbent position, but the swelling is persistent. There is usually an absence of a history of traumatism, rheumatism, or gout, but in some instances chronic urethritis is present. Attention has since been called to the affection by Schuller and Rosenthal. Raynal and Kirrison have described a “peri-tendinous cellulitis of the tendo Achillis” which does not agree with the condition described, nor does it agree with the description by Pitha, a “partial rupture of the tendo Achillis” and “partial evulsion of the insertion of the tendo Achillis,” the symptoms of which agree with the condition here described,



FIG. 644.—METATARSUS VARUS (Jones).

except that it is unilateral. Albert suggests that achillodynia is analogous to a condition known as "rider's strain," which occurs at the point of the attachment of the great adductor magnus. If this condition be analogous to the one met in horseback-riders, it should be more common in professional dancers, but such is not the case. Achillodynia has been ascribed to the enlargement of the synovial sac and to the presence of a neuroma between the tendon and the adjacent structures; a unilateral case of this kind has been reported. The etiology is unknown. Eshner describes the cardinal symptoms of this affection



FIG. 645.—SKIAGRAPH OF METATARSUS VARUS (Jones).



FIG. 646.—SKIAGRAPH OF METATARSUS VARUS (Jones).

as follows: "The circumscribed character and symmetry of involvement, the thickening above the heels, the absence of inflammatory symptoms, the presence of pain only after walking, and the rapid subsidence of a first attack."

The treatment of achillodynia consists in rest to the foot with direct injections of a 10 per cent. solution of iodoform-glycerin and the application of an aseptic dressing. Inunctions of mercurial ointment have been used with success. If a neuroma be present, it should be excised.

Retro-calcaneal Bursitis.—Synonyms: Achillobursitis; Post-calcaneal bursitis; Anterior achillobursitis. Inflammation of the bursa between the

tendo Achillis and the tubercle of the os calcis is usually the result of direct injury or severe muscular action. The acute form usually results from participation in violent exercises which directly injure the bursa, or from pressure from ill-fitting shoes. It may, however, be secondary to rheumatism, gout, syphilis, gonorrhea, tuberculosis, or influenza. Occasionally it may result from septic infection.

The symptoms are marked local tenderness over the insertion of the tendo Achillis. Swelling is present, and if the condition persist there is considerable broadening of the heel with exostosis of the calcaneum. The *x*-ray is of value in showing the outgrowths of bone. Attention has been called by Painter to the association of retro-calcaneal bursitis and exostosis of the calcaneum. Pain may be experienced in the calf muscles from the voluntary effort of the patient to arrest motion.

The treatment consists in putting the part at rest and in removing the pressure of ill-fitting shoes. In severe cases the foot may be fixed in a plaster-of-Paris dressing midway between flexion and extension. Massage and hot air will be found of value and counter-irritation with iodine or the cautery should be employed. The bursa if greatly enlarged may be aspirated, or if infected it should be opened and thoroughly curetted. The constitutional condition which gives rise to the local disease should be treated. Tuberculosis of the retro-calcaneal bursa will require excision. The exostoses which are present should be removed.

Painful Heel.—Severe pain accompanied by tenderness is sometimes experienced in the center of the heel about the posterior attachment of the plantar fascia. It has been described as “policeman’s heel,” but the writer has observed it in children. The cause is obscure, but is in some cases associated with flat-foot, or it occurs as a result of traumatism, and particularly from strain from sudden efforts, such as are made in acrobatic feats. It is sometimes due to inflammation of the bursa beneath the calcaneum. Gout is a predisposing cause. Occasionally exostoses are met, and these probably indicate a traumatic origin for the affection, the periosteum having been torn off in some sudden effort.

Treatment will depend upon the cause. If due to flat-foot this should be corrected. If neuroma be present in the bursa or its vicinity, it must be excised. Access to this bursa may be had through a curved flap about the heel, which may be turned forward, exposing the deep structures, as Duplay suggests. If the bursa be enlarged, it should be incised and curetted.

Exostoses should be removed. Palliative treatment consists in increasing the depth of the hollow of the heel in the shoe, the use of hair insoles, and rubber heels.

Exostoses of the Tarsal Bones.—Under the title of *pied-forcé* there has been described by the French military surgeons, Boisson and Chapotot, a painful condition of the feet occurring among soldiers as a result of prolonged marches. Pain and swelling of the dorsum of the foot, resulting in disability, followed by exostoses, particularly of the second metatarsal bone, are symptoms of the affection. The only condition which this resembles is gout. The acute attacks of gout met with over the instep are often misleading, and the severe erythema which sometimes accompanies cardiac disease should be promptly recognized. Severe itching of the soles of the feet and eyelids should direct attention to the lithemic condition. Both these conditions are precipitated by injurious pressure from shoes too tight over the instep.

Exostoses of the tarsal bones are met in other parts of the foot as a result of strain and overuse. The prominence of the first and second metatarsal bones which is met with in inherited gout should not be confounded with the exostoses occurring from other causes. This is a very common condition, and gives rise to an exaggerated arch, considered by some as a mark of distinction. The latter is unaccompanied by pain and is a hereditary condition. The exostoses are best investigated by means of a skiagraph, and their removal is not always followed by relief.

The treatment consists in baking in a hot-air apparatus, massage, anodyne applications, and rest. The shoes may be improved sometimes by increasing the depth of the heel, and by the use of rubber soles and heels.

Erythromelalgia.—Under the name of erythromelalgia Weir Mitchell has described a condition of the feet characterized by excessive fatigue, at first after long walks, and subsequently after slight exertion, arising in the summer. In one instance I attributed the cause to repeated exposure of the feet to severe cold. The burning pain at first becomes severe, but is relieved by rest, cooling applications, and elevation. The feet are red and swollen upon the slightest exertion, with elevation of temperature, which symptoms rapidly subside upon resting. The condition is due to vasomotor paralysis of the extremities, and is most common in males over thirty-five. Males are more frequently affected than females. Thus, in 27 cases collected by Weir Mitchell, only 2 were in females. I have seen the severest cases in females.

The treatment consists of rest, the application of cold, resort to a cold

climate, and nerve-section in suitable cases. A case of nerve-section followed by recovery is recorded by Weir Mitchell.

Pododynia.—Under the title of pododynia Gross has described a painful condition occurring in tailors. Upon assuming the erect posture pain and tenderness of a deep-seated character, increased upon pressure, are experienced. Pain is also felt in walking and standing, the swelling is slight, and discoloration rarely occurs. This disease is in some way related to the preceding one, but its exact cause is unknown. It is probably due to the strain thrown upon the insertion of certain muscles from the sitting position assumed by tailors.

Plantar neuralgia from a variety of causes is not uncommon. It is technically known as **plantalgia**. The most common cause is from stretching or rupture of the plantar fascia in pes cavus, and I have known it to follow tenotomy of this fascia and be accompanied by induration and sensitiveness to pressure. In severe cases excision of the sclerosed tissue may be required. The plantar neuralgia present in flat-foot as the result of pressure upon the plantar nerves by the displaced bones has already been referred to in its proper place.

In examinations of all painful affections of the feet the surgeon should not overlook the possibility of their being due to gout, to rheumatism, or to cardiac or renal disease.

CHAPTER XXIX.

CONGENITAL DISLOCATIONS OF THE HIP, KNEE, SHOULDER, AND ELBOW.

CONGENITAL DISLOCATION OF THE HIP.

Congenital dislocation of the hip is a displacement of the head of the femur, occurring before birth, due in most cases to arrest of growth or retarded development of the acetabulum, and tending, without treatment, to remain stationary or to grow worse. The deformity, in the strictest sense, is not a dislocation, but more properly a misplacement, since there is an arrest of development of the constituent parts of the joint, and some of the most important elements of a luxation, as the rupture of the capsule, are absent. The designation of "dysarthrosis congenita" and "congenital malposition," or "congenital misplacement," would therefore seem more appropriate, but the term congenital dislocation will be here retained on account of its general acceptance.

Frequency.

While in itself not a common affection, congenital dislocation of the hip is the most frequent of all congenital dislocations. Thus, Krönlein observed ninety cases of this affection to one of the knee, five of the humerus, and two of the radius. Its relative frequency is a little less than one in a hundred cases of surgical disease; thus, in 7900 cases of surgical disease treated at the Boston Children's Hospital, 39 were cases of congenital dislocation of the hip. Of 370 cases treated by Hoffa, 321 were girls, 49 were boys; 140 were double and 230 were single.

Dollinger, in 859 cases of deformity, found that there were 9 cases of this affection, or 1.1 per cent. Chaussier, in 23,292 newborn children at the Paris Maternity, found only one case, whereas Parisé found congenital dislocation of the hip three times in 332 autopsies upon newborn children at the Hôpital des Enfants Trouves.

During the last fifteen years 120 cases of this affection have come under my observation. Of these, 17 were boys, 103 girls; 80 were single and 40 double.

The relative number of boys and girls and the relative distribution of the affection are well shown in the following table, arranged from various sources:

STATISTICS OF CONGENITAL DISLOCATION OF THE HIP.

	CASES.	BOYS.	GIRLS.	RIGHT.	LEFT.	DOUBLE.
Orachmann,.....	77	10	67	24	24	29
Pravaz, Jr.,.....	107	11	96	29	27	51
Krönlein,.....	85	14	71	22	32	31
Hoffa,.....	370	49	321	104	126	140
Lorenz,.....	671	82	589	225	196	245
Kirmisson,.....	82	9	73	31	20	31
Whitman,.....	500	87	413	135	318	136
Boston Children's Hospital,.....	24	0	24	11	7	6
New York Orthopedic Hospital,.....	20	2	18	10	5	5
Milan Polyclinic, Bernacchi,*.....	1039	172	867			
Young,.....	120	17	103	36	44	40
Prahl,†.....	18	3	15	0	0	0

From these statistics of 3113 cases of congenital dislocation of the hip, 456, or 14 per cent., were in males; and 2657, or 86 per cent., were in females. The females were affected seven times more frequently by the deformity than were the males. The unqualified assertion of Dupuytren, that females are more liable to malformation, is the only reason which has ever been advanced to account for this preponderance. That this may be due to an anatomic peculiarity would seem to be proved by the conclusions of Heusner‡ and Marcwald, who found in female fetuses a disproportionate laxity of the capsule. It is also apparent from these statistics that single dislocation is more frequent than double, and that the left side is more frequently affected than the right.

Etiology.

As in the study of the causes of all congenital affections, there is in this much that is speculative and purely theoretic. Dislocation of the hip differs from other congenital affections in that it is rarely associated with other deformities, the children being usually otherwise well formed and healthy. The writer has, however, seen an instance in which there was congenital deficiency of the femur, tibia, and other parts associated.

The numerous theories which have been advanced may be considered under the following heads:

* Bernacchi, "Zeits. f. orth. Clin.," vol. ii, p. 275.

† Lovett, "Diseases of Hip-Joint," 1891, p. 183.

‡ "Zeits. f. orth. Clin.," 1902, Bd. x, H. 4.

1. Theory of heredity.
2. Theory of mechanical intrauterine pressure or traumatism.
3. Theory of pre-natal disease.
4. Theory of arrest or defect of development.

1. **Heredity** exerts a powerful and important influence over the occurrence of this deformity, and may explain, as pointed out by Vallette, the frequency of this affection in certain parts of France, a fact also referred to by Albert,



FIG. 647.—UNILATERAL DISLOCATION OF HIP (BACK VIEW).



FIG. 648.—SAME (FRONT VIEW).

who met with it exceptionally often in the Tyrol. As an etiologic factor its influence can scarcely be doubted. Persons suffering from this deformity may leave several children similarly afflicted, and individual hereditary cases are recorded by almost all writers. Redard cites an instance where a normal parent gave birth to three daughters, all of whom had double dislocation, and Zwinger cites a case where a mother deformed by dislocation had three daughters similarly afflicted. The case of Margaret Cardas, reported by Dupuytren, eight of whose relatives were similarly afflicted, is particularly interesting.

2. The theory of mechanical intrauterine pressure, or traumatism, through deficient liquor amnii, compression, or the peculiar position of the fetus *in utero*, or by a fall or blow, is as old as medicine itself. Hippocrates himself averred that "infants in the very womb may have their joints dislocated by a fall, a blow, or compression." Cruveilhier, Roser, and Lucke have supported the uterine compression view due to deficiency of the amniotic fluid, strong adduction being induced in this manner.

External violence to the mother is believed by some to account for occa-



FIG. 649.—BILATERAL DISLOCATION OF HIP (FRONT VIEW) (Hopkins).



FIG. 650.—SAME (SIDE VIEW).

sional cases. Thus, three cases were attributed to a fall in the seventh month of pregnancy by Kleeburg, Chatelain, and Zielewicz. The violent muscular movements of the fetus itself have likewise been ascribed as a cause, and Chaussier quotes a case of congenital dislocation to the forearm in support of this theory.

The arguments against the pressure theory under the etiology of congenital club-foot apply with greatest force here, since congenital dislocation of the hip is very rarely associated with other deformity; there is no appreciable difference observed in the quantity of liquor amnii over previous births of

normal children, and but few cases are recorded where the cause can be directly traced to external or internal traumatism to the fetus. Moreover, external violence would produce fracture *in utero* rather than dislocation.

The large proportion of breech deliveries in these cases has been cited as corroborative evidence of traumatism as a cause of congenital luxations. Adams reports seven breech presentations in forty-five cases. The necessary obstetric operations employed in breech deliveries may and frequently do, cause dislocation,—the so-called **obstetric dislocations**,—which, if unreduced, will later in life resemble in every respect congenital dislocation; but such cases should not be classed as congenital, but as traumatic. Such a dislocation is more liable to occur if the upper rim of the acetabular cavity be deficient, but that it is possible with a normal cotyloid cavity is illustrated by the experiments of Melcher, of Vienna, upon the cadavers of women who had died undelivered. He found it possible to produce dislocation with the fingers or a hook in six instances in which the acetabulum was perfectly formed. Phelps reported a case of obstetric dislocation of the hip which he reduced one hour after birth.

From the experiments of Allis and others it would seem to be demonstrated that a certain proportion of cases are the result of traumatism. When dislocation of the hip is produced by pressure, or traumatism, it may easily be effected if the femur is flexed, adducted, and rotated inward; and the greater the degree of these angles, the easier is the production of the dislocation. These conditions are found to be present in the fetus in the normally flexed position of the femur and the adduction which is present, and it may be assisted by the deficiency of liquor amnii, or by the small size of the uterus and the presence of internal rotation, which is also normal in early fetal life. Internal rotation is always associated with adduction; for example, if a person sitting in a chair adducts his knees, the foot is inverted, during internal rotation of the femur. When dislocation occurs in this way, the force is probably applied to the distal extremity of the femur, which is the best possible manner in which to apply the leverage. With these three conditions present, flexion, adduction, and internal rotation, a moderate amount of force gradually applied would probably produce the deformity.

The greater frequency of congenital luxations of the hip in girls may also be explained upon mechanical principles from the fact that, as stated by Cunningham, the sexual differences of the pelvis are as pronounced in the third or fourth month of fetal life as they are in the adult, and therefore the greater

breadth of the pelvis, with the femur in the position described, would result in a larger proportion of this deformity in girls.

The traumatic theory does not explain certain conditions which are found to be present. The fact that the capsule is not torn may be accounted for by the time which has elapsed since the production of the deformity, it having had time to repair; or if the deformity occurred gradually, the capsule may have been stretched. The obtuse angle of the neck of the femur can be accounted for by the pressure of the femur upon the ilium after the dislocation has occurred. The production of an occasional anterior displacement can also be accounted for by this theory, by forward displacement from a previous posterior dislocation during the delivery.

From a careful consideration of the different theories which have been advanced and an examination of a number of specimens, it appears to the writer that a certain number of these deformities are produced by traumatism, probably 50 per cent. Of the remaining, a certain percentage, perhaps 20 or 30 per cent., are probably due to arrest of development, the former being entirely amenable to treatment and the latter only partially so. The remaining percentage can be accounted for by the other theories.

3. **The theory of pre-natal disease**, or the musculo-nervous theory, due to intrauterine lesions identical with post-natal diseases, has been supported by a host of eminent authorities.

(a) According to some, the dislocation is spontaneous, being due to softening and looseness of the coxo-femoral ligaments, to effusion and fungous synovitis, to hydrarthrosis, or to caries, arthritis, or other destructive joint inflammations.

(b) According to the majority, it is due to primary muscular contraction, which is to be regarded as secondary and consecutive to a central nervous lesion.

(c) According to a few, it is regarded as often the last stage of a paralysis and atrophy of the peri-trochanteric muscles, and the frequency of the dorsal iliac dislocations over other forms is cited as confirmatory. In regard to this theory it may be remarked that the analogous deformities from which this theory was derived—club-foot, wry-neck, and scoliosis—are not now regarded as the result of primary muscular spasm; central cerebral and spinal lesions have not been demonstrated; and the anatomy of the hip-joint is such that muscular spasm, independent of other causes, could not produce dislocation. Moreover, the dislocation is not always, as it should be, upward and backward,

but may be upward and forward, or downward and forward, or downward and backward. While in anencephalous fetal monsters the association of congenital dislocation of the hip, club-foot, and other deformities is confirmatory of this theory, many monstrosities with extensive demonstrable nervous lesions have no deformity of the extremities whatever.

4. **The theory of arrest or defect of development**, or the osseous theory, has received the weight of modern authority as rational and scientific. Proposed by Paletta, indorsed by Von Ammon and others, it has of late years been confirmed and established upon a scientific basis. In considering this theory it must be remembered that the acetabulum is formed by the growth of the pelvic cartilage around the head of the femur, which by the third month is a deep cup-like cavity. Dollinger believed the cause to be a premature ossification of the Y-cartilage of the acetabulum, while Grawitz, from the examination of specimens and numerous and careful experiments, including microscopic examinations, seems to have demonstrated it to be due to arrest of development of the same. The same lack of development of the acetabulum is observed from non-use after luxation of the head of the femur, and it has been questioned whether this condition is primary and causative or secondary from non-use. The observations of Grawitz would seem to prove the former. The malformation may consist of the absence of a rim to the acetabulum, with or without displacement of the head of the femur, as in two specimens reported by Lockwood. This theory makes congenital dislocation of the hip analogous with other deformities, explains its association with other malformations, and offers an explanation for those cases which are not due to traumatism or pre-natal disease.

The facts which support this theory are that the capsule is found to be untorn and the joint is found to be undeveloped. But it would not account for the vast majority of posterior luxations, it would not account for the occasional anterior displacements, it does not account for the large number of cases occurring in girls, nor does it explain the obtuse angle of the shaft with the head of the femur.

Pathology.

Prior to 1890, when the open operation was first performed, the descriptions of the pathologic anatomy of congenital dislocation of the hip were based upon the original observations of Dupuytren, autopsies upon new-born children, and a few authentic specimens in museums. Since that time the descriptions

of Hoffa, Lorenz, Schede, and other operators, together with the study of the Röntgen-ray pictures, have added greatly to our exact knowledge of the subject.

The dislocation may be complete or incomplete; the incomplete luxation at birth usually becomes converted into a complete one, as soon as the child begins to walk, from the weight of the body. The position of the head is usually backward upon the dorsum of the ilium, but it may be upward, resting above the acetabulum, or forward, the head lying beneath the anterior superior spine



FIG. 651.—SKIAGRAPH SHOWING UNILATERAL DISLOCATION OF HIP.

of the ilium. The primary position in newborn children is probably directly upward, or upward and slightly backward.

The pathologic changes are of two kinds—those found in the affection itself and those produced by walking upon the deformed joint. For convenience of description the pathologic anatomy is best considered as it occurs, in the newborn, in children who have walked, and in adults.

At Birth.—In autopsies upon newborn children the **acetabulum** is undeveloped and narrowed, elongated, less concave than normal, covered with normal hyaline cartilage, and occasionally filled with fat and connective

tissue. The acetabulum is seldom, if ever, found to be entirely absent, though the upper part of the cartilaginous rim may be wanting; in which event the cavity is continuous with the surface of the ilium.

The **head of the femur** is occasionally irregular and atrophied, but is always slightly larger than the concavity of the acetabulum. The neck is conical, short, and the angle formed with the diaphysis is less obtuse.

The **round ligament** is abnormally long, filiform in shape, occasionally more developed than normal, and seldom if ever absent.

The **capsule** is thinned and capacious and the cavity is distended with fluid. When the head is reduced by traction, inward rotation, and extension, the upper part of the capsule becomes wrinkled, while the anterior and posterior fibers are tightened.

The **muscles** about the joint become atrophied and retracted by the changed relations; the quadratus femoris, obturator externus, psoas, and iliacus being particularly influenced by the displacement upward of the femur. Verneuil found in an autopsy upon an infant affected with congenital dislocation of the hip of the left side that the muscles of the affected side were less developed and shorter than the right, and Lannelongue found an atrophy of the entire dislocated leg, but without one trace of degeneration.

The **pelvis** is compressed laterally, the direction of the os pubis is less inward than in the normal bone, and the superior and inferior straits are contracted.

In Children Who Have Walked.—In subjects who have walked the changes are more marked and progressive.

The **acetabulum** is smaller, triangular, and filled with fat or firm fibrous tissue. Under the influence of walking the head tends to elongate the cavity. One or more depressions exist where the head of the femur has rested, and on the position of these new sockets depends the angle of the pelvis and the amount of lordosis, for if they form directly above the acetabulum, the normal plane remains practically unchanged; but if they are much behind, the pelvis is tilted and severe lordosis results. A partial rim of bone sometimes forms above and around the new socket, to which is attached the capsular ligament. The surface of the ilium is smooth and where the head of the femur rests it is indurated and eburnated.

The **head of the femur** is small, conical, and generally flattened at its posterior superior segment from pressure upon the dorsum of the ilium.

The **neck** is shortened or entirely wanting, the head resting immediately

upon the diaphysis. Generally it is undeveloped and placed obliquely in a position of anteversion, lessening, and in many instances increasing, the forward inclination of the neck.

The **capsule** is relaxed, enlarged, and thickened, and in some cases is constricted into the form of an hour-glass. The communication between the



FIG. 652.—SKIAGRAPH SHOWING BILATERAL DISLOCATION OF HIPS.

two parts is sometimes obliterated after the disappearance of the round ligament. The capsule is inserted about the upper portions of the old and new acetabuli.

The **ligamentum teres** is flattened and thin, sometimes arising by two heads, and in others being entirely absent. Its presence prevents adhesion between the narrowed portion of the capsule, where the interior portion of the capsule rests against the upper border of the acetabulum.

The **muscles** are displaced by the changed relations of the articulation, some being lengthened, others shortened. The obturators, gemelli, and pyramidalis are lengthened, while the psoas, iliacus, rectus, tensor vaginæ femoris, hamstring muscles, and the adductor group, particularly the middle and lower portion of the adductor magnus, are shortened, as pointed out by Bradford.*

In a recent case where I assisted Hoffa, at the University Hospital, Philadelphia, with a single open reposition in a boy six years old, the anatomical parts were characteristic of the deformity at this age.

In Adults.—In adult cases the changes are all advanced; exostoses fill the cavity of the acetabulum and form an elevated border above the new socket.

The **head of the femur** becomes more displaced and may rest immediately upon the ilium.

The **capsule** may be absorbed by friction in its posterior part. Above it becomes greatly thickened, and may become ossified where it is attached to the osteophytic upper portion of the new acetabulum. The new cavity may be sufficiently deep to afford good support.

The **muscles** become more and more displaced, and such as are unable to functionate, as the gluteal, become degenerated. The psoas, iliacus, and peri-trochanteric muscles are contracted, as are also the ligaments and fascias upon the anterior portion of the articulation.

The **pelvis** is suspended by the capsules, as pointed out by Volkmann, as the old-fashioned stage-coach was hung upon its leather springs. The pelvis becomes contracted above and expanded below, and the iliac bones are carried backward and upward.

The pelvic changes in bilateral congenital dislocation of the femora have been particularly observed by Kleinwachter, Schauta, and Lassman, the latter having recorded twenty-seven cases. The anatomic changes in the pelvis are produced by traction of the muscles, especially the psoas, and of the ligaments in a transverse direction, causing a lessening of the inclination of the pelvis, and lumbar lordosis due to the position of the heads of the femora. Parvin states that tension upon the pelvic ring causes increase in the transverse diameter of the inlet, and flattening of the pelvis, with necessary shortening of the true conjugate; the latter diminution being increased by the sinking forward of the sacrum; "because of this the promontory is also more marked." The

* "Trans. Amer. Orth. Assoc.," vol. xvi, p. 238

true conjugate is rarely below 9 cm., but in some cases has been reduced to 7 cm.

The characteristics of this pelvis are: (1) The double luxation and increase in bi-trochanteric diameter. (2) The increased transverse diameters both external and internal. (3) The decreased antero-posterior diameters, internal and external. (4) The greater breadth of the pubic arch. (5) The lessened depth and therefore the shortening of the birth canal. (6) The lessening of the inclination of the pelvis.

The mechanism of labor is said by Garrigues to be much like that in the flat rachitic pelvis. Labor not infrequently ends spontaneously, but there may be difficulty in engagement because of small conjugate or malpresentation, to which these cases are prone because of the lessened inclination and pendulous abdomen. In only nine out of the twenty-seven cases of Lassman was there a favorable outcome.

The pelvis is usually atrophied on both sides in bilateral dislocations. The pelvic bones are slender, probably from the same defect which makes the acetabulum imperfect. The attachment of the gluteal muscles being nearer together does not permit of the normal pull upon the alæ, and they are more nearly vertical than normal.

In regard to the changes observed in the pelvis in unilateral congenital dislocation of the femur there is a difference of opinion among the various obstetric writers, some of whom, Davis among them, class the pelvis as similar to the Naegele pelvis, while the majority define the deformity produced as being exactly opposite to that produced in the Naegele pelvis. The pelvis in unilateral luxations is similar in character to the coxalgic pelvis, and is very much like the Sitz pelvis—*i. e.*, one in which one lower extremity is wanting.

As is usual in unilaterally deformed pelvises, the effect upon labor is marked and the diagnosis of the deformity easy. Unilateral deformity of the pelvis was observed much earlier than some of the more common bilateral deformities. Dionis, in his "*Traité General de Accouchemens*," 1708, states that "the lame who have one of the hip bones higher than the other sometimes have great difficulty in labor because the basin formed by these bones is not exactly round and the infant is obliged to redouble its efforts in order to go through the passage." Hatin, Paris, 1827, also mentions the pelvis of the lame in "*La Manœuvre de Tous les Accouchemens contre Nature*."

In regard to the anatomic changes there is a great difference in degree and variety, partly depending upon the degree of deformity. The weight of the

body is thrown mainly on the other leg and the corresponding side of the pelvis is therefore forced upward. When the head of the femur is displaced forward, the anterior half of the pelvis is driven inward on the pelvic canal. In one case mentioned in the "American Text-Book of Obstetrics" the head of the thigh bone projected over the horizontal ramus of the pubis into the pelvic inlet. The symphysis is drawn to the affected side and the epitrochanteric line may lie any distance above the os pubis and even reach the iliac spine. The posterior iliac spine on the affected side approximates the crest of the sacrum. The deformity is greater at the inlet, but may be very great at the outlet because of the coccyx being pulled forward and to the affected side and the driving in of the symphysis on the birth canal. The inlet is oval in shape, as in the Naegele pelvis, but the small point of the oval is directed toward the os pubis and not toward the sacrum. In other words, it is precisely the opposite diagonal of the inlet which is lessened: The antero-posterior diameter is not very greatly diminished. The transverse diameter is somewhat diminished. The Naegele pelvis also differs in the fact that the symphysis is in this case pushed toward the healthy side and the pubic arch also faces in the same direction.

The outlet is deformed sometimes in both the antero-posterior (which is now not coincident with the antero-posterior diameter of the trunk) and the transverse diameters. The coccyx is drawn forward and upward, the pubic arch is decreased, the shape of the arch deformed, and the spines of the ischium are pushed inward and upward. The axis of the pelvic canal is atypical and causes anomalies in mechanism. The pelvis is not, as a rule, excessively contracted, and Prouvost reports that forty out of fifty cases end spontaneously, contrasting favorably with the report of Litzman in Naegele pelvis, in which there were 22 deaths in 28 cases of first labor, 5 undelivered, 3 cases dying after second labor, and 2 after sixth labor. The mechanism in an obliquely contracted pelvis is similar, as a rule, to that in a generally contracted pelvis. Even in mild cases there is great danger of maternal and fetal injury—in fact, the infant mortality is very high.

In unilateral cases there is usually atrophy of the affected side, and scoliosis is present, the convexity being toward the affected side, and in some instances a compensatory curve may form in the dorsal region.

In a recent case of pseudo-arthritis in a girl of sixteen, with which I assisted Hoffa, the head was well formed, only slightly flattened, the right ligament was wanting on one side, and the neck was very short.

Symptoms.

The affection is characterized by the peculiar gait and by the deformity.

In unilateral dislocations the gait becomes an exaggerated limp, the limb is short, the pelvis flexed and tilted, and lordosis and scoliosis are present. As the patient rests the weight upon the affected side the pelvis sinks downward and forward, and as the pelvis is elevated for the forward movement of the leg the limb lengthens and the foot remains for an interval upon the ground. Walk-



FIG. 653.—BILATERAL DISLOCATION OF HIPS (SIDE VIEW).



FIG. 654.—SAME (BACK VIEW).

ing is difficult, and children subject to this deformity become fatigued easily and complain of pain after walking one or two miles.

Viewed from in front, the patient standing, the shoulder on the affected side is lowered, the pelvis is tilted if the foot rests upon the floor, but it remains level if the subject compensates by allowing hyperextension of the sound limb in a position of genu recurvatum, or by raising the heel. The trochanter is prominent on the affected side. The limb is atrophied throughout, and, according to some, hemiatrophy of the cranium, face, and thorax may also be present.

Viewed from behind, the prominence of the trochanter is more apparent, and the lordosis and scoliosis are observed unless the patient compensates.

In the recumbent position the dislocated joint is excessively mobile, free from swelling or pain. Measured from the anterior spine to the malleolus, the luxated limb is shorter than the sound limb, and if an imaginary line be drawn from the anterior spine to the tuberosity of the ischium, the trochanter is from $\frac{1}{2}$ to $2\frac{1}{2}$ inches above, but may frequently be brought down by traction. In some instances a depression may be felt and observed in the inguinal region over the normal position of the head of the femur. The knee is adducted and the foot rotated outward. Adduction of the hip is increased, abduction is limited, and all the other movements are exaggerated.

In bilateral cases the child walks very late, and waddles with a peculiar, goose-like gait, with marked lordosis, flexion of the pelvis, and protrusion of the abdomen. In a few instances some of the symptoms present in unilateral deformity are observed in bilateral cases on the side most affected.

Viewed from in front, the abdomen is pendant, the hip prominent, the trochanters are conspicuous, and the lower extremities relatively short, the body and arms relatively long, the knees flexed and adducted, the feet turned outward. The perineum is very broad, leaving a triangular space between the thighs, with the base up.

Viewed from behind, the lordosis is excessive, or moderated, depending upon the position of the head of the femur, whether backward, upward, or forward. The prominence of the trochanters is accentuated by the atrophy of the gluteal muscles and the adduction of the femur. The degree of lameness and disability varies greatly, and increases with age, but is never so marked as in unilateral deformity. In very rare instances, according to the observations of Redard, inflammation may supervene and the subject become incapacitated by severe attacks of pain.

Pain in the muscles about the hip, in the lumbar region, increased upon locomotion, is common in older subjects, and most adults have been compelled to use crutches or to be confined to bed at some time during their existence. In young people the freedom from disability in bilateral dislocations is sometimes surprising. I have seen a child of twelve jump with agility from a table to the floor, and another patient of sixteen could dance and skate without any inconvenience whatever.

Diagnosis.

In very young children the affection is frequently overlooked, but in adults the diagnosis can often be made at a glance. The diagnosis rests upon the history, the prominence of the trochanter, excessive mobility of the joint, width of the pelvis, and especially the position of the trochanter in its relation to Nélaton's line, drawn from the anterior superior spinous process of the ilium to the tuberosity of the ischium. Instead of being in a line, the trochanter is usually from one and a half to two inches above. Especially valuable is the Röntgen-ray photograph in diagnosing this affection.

The unilateral displacement may be confounded with traumatic dislocation, acute epiphysitis, separation of the epiphysis, hip disease, and infant paralysis, from which the following differences will distinguish it. In acute epiphysitis of the head and neck of the femur the physical signs are identical with congenital dislocation, but the history of a general septic infection, usually through the umbilical cord, with local suppuration, will aid in arriving at a correct diagnosis. An x-ray photograph will be especially valuable as showing the entire absence of the epiphysis on the affected side. The discovery of a cicatrix from an incision into the joint, or from spontaneous rupture of the joint contents, would be suggestive, and where this is absent cicatrices may usually be found over other epiphyses which have been the seat of coincident suppuration.

In traumatic dislocations the history of an obstetric injury and the early fixation of the joint are distinguishing points. The firmness of the joint after reduction will confirm the origin of the injury. Separation of the epiphysis will be indicated by fixation of the limb, swelling of the joint, and eversion and shortening of the limb. In hip disease the spasm, atrophy, deformity, pain, abscess, and other symptoms are distinctive. In infantile paralysis the gait, laxity of the hip-joint, and inequality of the limbs resemble dislocation, and where paralytic dislocation exists also, the condition is confusing; but the history of paralysis, the cold and atrophied limb, the laxity of all the joints of the limb, and particularly the electric reactions serve to distinguish it.

The bilateral affection must be distinguished from bow-legs, coxa vara, and pseudo-muscular hypertrophy. In bow-legs the waddling walk and marked lordosis resemble this affection, but the normal condition of the hip is decisive, although both affections may coexist. Congenital dislocation of the hip will frequently be mistaken for adolescent coxa vara of rachitic origin, on account of the high position of the trochanter and the limitation of abduction of the

limbs. The fact that the trochanter cannot be drawn down by traction, and the head of the femur can be felt in its proper relation to the acetabulum, should render the diagnosis sufficiently clear, but if any doubt exist, the Röntgen-ray picture will remove it. The marked lordosis and the imperfect use of the lower extremities in young children suffering from pseudo-muscular hypertrophy may resemble this deformity, but the normal position of the head of the femur, the slight prominence of the trochanters, the excessive development of the calf muscles, and atrophy of the latissimus dorsi, teres major, and lower part of the pectoralis major, would serve to differentiate the latter affection.

Prognosis.

When Dupuytren in 1826 pronounced this affection not only incurable but not amenable to treatment, he expressed the opinion which was subsequently held by most competent surgeons for nearly three-quarters of a century. The therapeutics of this affection, however, have made such progress of late years that instead of being, as formerly considered, an incurable affection, it may now be considered, within certain limits, as curable. The percentage of recoveries depends upon the age of the individual and the amount of deformity of the head and neck of the femur. Before the age of seven years the percentage of cured cases is large; after that age the chances of recovery diminish rapidly. Much will depend upon the muscular development, shortening, and rigidity. The possibility of reduction is limited by the age of the individual. In bilateral cases the age limit for forcible reduction should be from the ages of seven to eight years, but in unilateral cases the age limit may be extended to from nine to ten years. Where there is great shortening, with rigidity, the open operation is performed, preferably between the ages of from four to six years. Where there is deformity of the head or neck of the femur, an improved functional result may sometimes be obtained even where the anatomic results may be faulty, but a perfect result is impossible under any form of treatment. These constitute at least 20 per cent. of all cases. Prior to or after puberty the operation for the improvement of the angle of deformity may be undertaken.

In considering the possibility of cure in any particular instance, the result in the event of failure should be compared with the condition of the individual if no operation has been undertaken. Without treatment the deformity appears either to remain stationary or to grow somewhat worse, no spontaneous cures ever having been reported.

Out of 364 cases of unilateral dislocations reported in 1905 by Lorenz,

218 gave anatomically good results, while 127 showed subspinal positions (anterior relaxation, upward and outward) and 19 showed lateral appositions.

"Out of 158 cases of bilateral dislocations, 70 showed good anatomic results on both sides, 19 resulted in subspinal positions on both sides, 7 showed lateral apposition on both sides, 49 resulted in anatomically good results on one side while the other side became subspinal; in 4 cases one side became anatomically replaced while the other side showed lateral apposition; in 9 cases one side was subspinal, the other lateral apposition. Taking all the

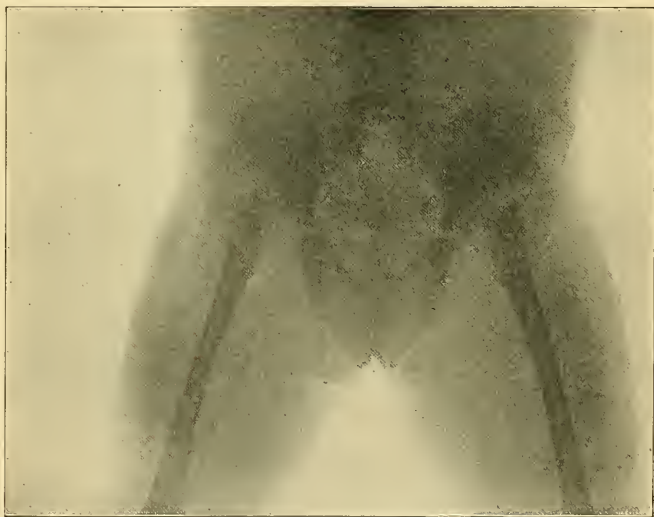


FIG. 655.—SKIAGRAPH SHOWING BILATERAL DISLOCATION OF HIP (BEFORE OPERATION) (Wilson).

hips together ($364 + \text{twice } 158 = 680$), 358 of these showed good anatomic results, *i. e.*, 52.6 per cent.—a good half of the cases."

Hoffa reports 250 cases of unilateral dislocation in which there were 75 good anatomic and functional results, 110 good functional results, and 65 unsatisfactory results, making 75 per cent. of satisfactory results.

Out of 65 cases of bilateral dislocation there were 7 good anatomic and functional results, 32 good functional results, 10 good functional results on one side with relaxation of the other side, and 18 relaxations of both sides, thus making about 60 per cent. of satisfactory results.

Hoffa reports having performed the open operation for reposition of the dislocation where the bloodless method had been unsuccessful, and gives 80 per cent. of satisfactory results in all his cases of congenital dislocation, by the use of the combined methods.

Treatment.

The treatment of congenital dislocation of the hip may be divided into:

Treatment by extension and apparatus.

Treatment by forcible reduction.

Treatment by operative methods.



FIG. 656.—SKIAGRAPH SHOWING BILATERAL DISLOCATION OF HIP (AFTER OPERATION).

Treatment by Extension and Apparatus.—To Buckminster Brown, of Boston, belongs the credit of having first obtained a perfect cure by the use of extension and apparatus. Cases have been reported in which benefit has resulted from the use of continuous prolonged extension, but in all of these cases there appears to have been some doubt as to the ultimate result. Moreover, the possibility of cure is so slight and the liability of relapse so great that the subject may be dismissed as unpractical. Corset and pelvic bands of plaster-of-Paris, silicate, or felt have been much advocated, especially by the Germans. These have their uses where nothing more radical or curative can be employed.

A plaster mold may be made while the patient is suspended, and from this a poroplastic splint made which may be worn during the day. Modifications of the long extension splint have been employed by many.

Treatment by Forcible Reduction.—To Post, of Boston, belongs the credit of having first forcibly reduced a congenital dislocation under an anesthetic; but to Hoffa, of Berlin, belongs the honor of having first performed, in 1890, the open operation of reposition, with success. This operation, which consisted in part of reducing the dislocation by manipulation, was subsequently modified by Lorenz, of Vienna, and by Hoffa himself, and has been so improved as to now consist, in early life, of a so-called bloodless reposition.

At present there are three different methods of forcible reduction which are in general use and of which short descriptions should be given:

1. The method of Paci.
2. The method of Lorenz.
3. The method of Hoffa.

The method of Paci.

This consists of four parts—flexion, abduction, external rotation, and extension.

First part: The patient being placed in the recumbent position upon the edge of a bed, or upon a flat surface, the pelvis is firmly secured by the assistants and the thigh is then fully flexed on the trunk and the leg on the thigh. This produces a relaxation of the muscles passing from the trunk to be inserted into the femur and leg. As a result of the flexion the femur is carried into the iliac fossa and is gradually brought to the insertion of the Y ligament. The head of the femur is thus moved downward to the edge of the acetabulum. The descent of the head may be increased by making light pressure upon the knee.



FIG. 657.—BRACE FOR CONGENITAL DISLOCATION OF HIPS
—AFTER TENOTOMY OF ADDUCTORS.

Second part: The surgeon then moves the femur outward in a position of abduction, the object being to place the head of the femur on an anterior plane to the edge of the acetabulum, or against its posterior border, if on account of the deformity of the neck of the femur and the resistance of the muscles the head has been arrested at this point.

Third part: The limb being still in marked abduction, the femur is carried by slow and gradual movement of outward rotation until the femoral head is carried on an anterior plane nearly to the acetabulum.

Fourth part: The surgeon, using the edge of the table as a support, slowly extends the thigh, one hand pressing on the knee and the other holding the foot and flexed limb, the whole limb being rotated outward until the femoral head, supported by the anterior muscles of the thigh, is placed forward, and the thigh can be fully extended parallel with the table. The head of the femur after its reduction is retained in its new position by the irritation and strain of the muscles produced by the movements. The movements should be executed with extreme slowness and without roughness, and in such a manner as to avoid laceration. Anesthesia is not, as a rule, necessary. A silicate of potassium dressing is applied for one month, after which extension is continued by means of a Volkmann apparatus for three months. At the end of this period certain walking exercises are prescribed, with the use of crutches, and later the patient walks, with or without a cane.

By this method cures are said to be effected in one year, the first reduction having been maintained. The method is most suitable for very young children who have not yet used their limbs. The percentage of cures reported is low compared with that of the other methods.

The method of Lorenz. The treatment by the Lorenz method consists of:

1. Preparatory treatment.
2. Reduction.
3. Retention.
4. After-treatment.

Preparatory treatment: The patient should be very carefully selected as regards age, the amount of contraction of the muscles, and the amount of shortening. The age limit for cases of double dislocation is seven to eight years, the preferable time for the operation being between four and six years of age. In unilateral cases, after a long period of preliminary treatment the age limit may be extended to nine or ten years.

The preliminary treatment, which consists in making extension by means

of six-pound weights, should be carried out for from ten days to twenty days, according to the severity of the case. The long muscles must be stretched,

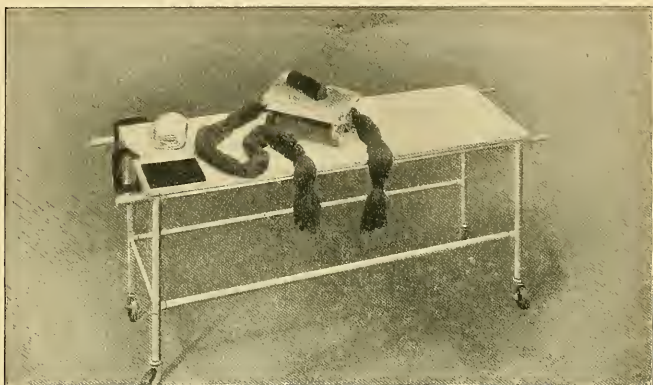


FIG. 658.—TABLE FOR LORENZ REDUCTION, SHOWING APPLIANCES (Wilson).



FIG. 659.—TEARING OF ADDUCTOR TENDONS (Wilson).

particularly the adductors, as this renders the reduction less difficult. The resistance of the anterior muscles may be overcome by stretching, and by bending

the knee. In many cases it is best to perform a preliminary subcutaneous tenotomy of the adductors, under anesthesia, two weeks before the final reduction, and if there is much contraction, the hamstrings, the sartorius, and the tensor fascia femoris may be divided. In young children and in selected cases these preliminary tenotomies need not be performed, but the adductors and other resisting structures may be torn at the time of the reduction.

To perform the reduction of the dislocation one should be provided with a low firm table, a small padded stool, an oak triangular wedge, 4 by 5 by 9



FIG. 660.—STRETCHING HAMSTRING TENDONS (Wilson).

inches, the upper sharp edge of which is covered with leather, a pelvic stool, a skein of heavy yarn, and a large sand-bag.

The operation itself consists of five distinct parts, which must be employed in the order given:

1. Hyperabduction and tearing of the adductors. The pelvis is fixed by the assistant, the limb is forcibly abducted, and the adductor muscles are separated from their attachments to the pelvis, by manual pressure, if they have not been previously tenotomized.

2. Hyperflexion. The patient being in the prone position, the lower extremity is slowly and forcibly flexed until the foot touches the ear, in a similar manner to the method employed in stretching the sciatic nerve.

3. Hyperextension. The patient lying upon the opposite side, the lower extremity is forcibly extended, the knee being bent.

4. Traction. The patient lying in the prone position, forcible manual traction is made upon the extremity, or by means of a skein of yarn fastened about the ankle, the pelvis being fixed by the hand of an assistant.

5. Reduction. The reduction of the head of the femur into the acetabulum is accomplished by placing a triangular wooden block beneath the trochanter, the patient lying in the prone position, and strongly abducting the thigh. After the head of the femur is reduced the anterior part of the capsule is enlarged



FIG. 661.—STRETCHING ANTERIOR MUSCLES (Wilson).

by hyperabduction of the thigh together with rotation. As a test that the reduction has been accomplished, the knee-joints cannot be extended beyond a right angle.

The dressing: The limbs are held in a hyperabducted position with the knees flexed, by means of a heavy plaster-of-Paris dressing. They are first encased in stockinet drawers, cotton batting, and muslin rollers, the perineum being entirely covered by figure-of-eight turns. A movable strip of muslin is inserted within the stockinet drawers with a free end extending above and below for the purpose of massage and cleanliness. From twelve to fifteen plaster-of-Paris bandages are applied, completely covering the muslin rollers.

The method of applying these plaster bandages is peculiar. In unilateral cases the roller begins at the anterior superior spine of the sound side, is carried across the pubis, over the inner surface of the affected knee, around which it is passed, and along the posterior surface of the body to the starting-point. It is then carried a second time across the front to the affected knee, around which it is passed. Circular turns are then applied to the affected side until the pelvis is reached, when this part is entirely covered by figure-of-eight turns.

In bilateral cases the application of the plaster bandage is still more complicated. Starting from the anterior superior spine of the right side, it is carried



FIG. 662.—REDUCTION BY MEANS OF THE TROCHANTERIC BLOCK (Wilson).

back of the right limb, around the right knee, across the pubis, to the left knee, around which it is passed. The left thigh is then covered in with spirals, the bandage then being carried across the pubis in a figure-of-eight turn to the lower third of the right thigh. Circulars are applied to the right thigh, and the entire pelvis is covered in by figure-of-eight turns. This is best illustrated by reference to Fig. 666.

After the application of the plaster bandages a large fenestrum is removed from the perineal region, and the dressing trimmed over the popliteal spaces, and above in front and behind. This dressing should remain on for six months.

As soon as the soreness and discomfort have disappeared, which will be within a week if tenotomies have not been performed, and shortly after two weeks if they have been performed, the patient should be encouraged to use the parts. The great advantage of this method, which is known as the functional weight-bearing method, is that the muscles are brought into action soon and atrophy does not occur.

In unilateral cases a high shoe, raised by means of a block four or five



FIG. 663.—PATIENT WITH CAST APPLIED (Wilson).

inches in height, should be worn on the affected foot, so that the patient may be able to walk, and in bilateral cases a small stool on wheels should be used, by means of which the patient can propel himself about and make use of the muscles.

In regard to the after-treatment, the first cast should be removed at the end of six months, or sometimes it may be removed after four months, and after its removal the use of a support may be discontinued entirely, or, what is better, the first cast may be replaced by another which will hold the limb

in a position midway between abduction and adduction, and midway between flexion and extension, that is, in a position of abduction of 45 degrees and of flexion from 115 degrees to 135 degrees. The block which has been worn should be reduced correspondingly, and subsequently it is gradually reduced until it is only one inch in height.

This second cast is worn for from four to six months, and upon its removal at the end of this period, the patient walks with the limb extended but with the foot still everted. During the daytime he remains without any apparatus or support, but in doubtful cases it is best to apply at night a removable ab-

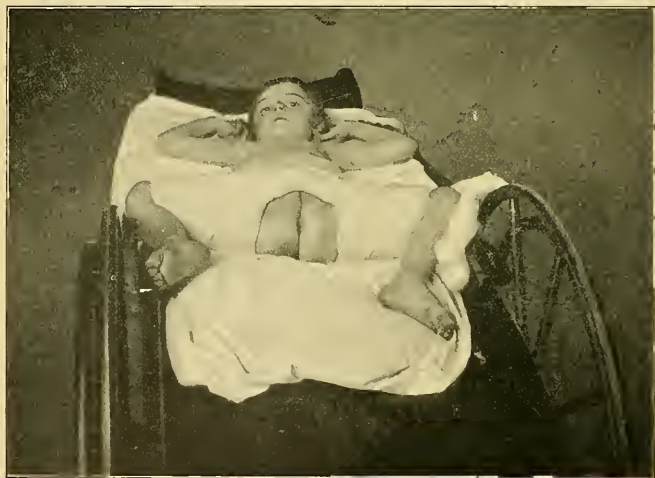


FIG. 664.—PATIENT WITH DRESSING COMPLETED (Wilson).

duction cast, which may be made of plaster, leather, or celluloid, in order to prevent any possible relapse during sleeping hours.

At this time certain gymnastic exercises must be begun. The importance of very careful gymnastic treatment, together with massage, cannot be overestimated, since there is a continuous struggle against contracture and ankylosis, and an effort to produce a good muscular support. The removal of the cast soon enables the muscular system to regain its strength, and although in some cases brilliant results have been obtained with but little after-treatment, yet the value of mechano-therapy should not be lightly dismissed, for in general

the completeness of the cure depends upon the most perfect attainable restoration of the muscular system. The reduction may be faultless from an anatomic standpoint, and yet the result from a prosthetic point of view is not entirely satisfactory to the surgeons.

The pelvic trochanteric muscles require the most attention, particularly the abductors, and the development of these muscles may be accomplished by certain set exercises. The patient in a standing position may take an active passive movement of abduction by a free movement of the affected limb in a frontal plane, throwing the limb backward and drawing it forward. Another very valuable movement is the active abduction of the limb, the patient lying on the side with the affected limb upward. The affected limb is then slowly raised, the effect of this exercise being increased by slight resistance on the part of the operator. Later the active abduction may be improved by teaching the child to stand on the affected limb and to draw the opposite side of the pelvis up high with the gluteal muscles contracted, and to hop upon the affected limb. This is at first difficult, but with persistence these exercises may be accomplished.

The foregoing exercises are to be used for unilateral cases. In bilateral cases the following exercises have proved very valuable in restoring the muscles.

First, the patient, lying on his back, abducts his limbs with as little assistance as possible, the limbs sliding along the surface of the table. A second movement consists in taking this same exercise but lifting the limbs in a diagonal manner from the table as they are moved outward. A third movement consists of the same exercise, but carrying the limbs in a still further abducted position. Additional exercises may be given with advantage, the child lying upon its face. In this position he flexes his knees in such a manner as to raise the thighs from the table and in this position abducts the limbs. This movement may be increased so that the pelvis and the entire lower extremities are raised from the table.



FIG. 665.—LORENZ CAST FOR UNILATERAL DISLOCATION OF THE HIP (Wilson).

Massage should be used from the time of the removal of the second fixation bandage. Both friction and kneading may be employed with benefit.

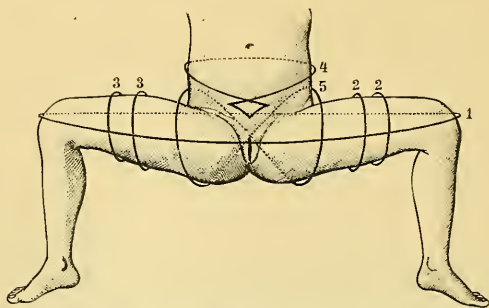


FIG. 666.—DIAGRAM OF TURNS OF PLASTER BANDAGE (Lorenz).
1, First turn of bandage; 2, spirals of left thigh; 3, spirals of right thigh;
4 and 5, figure-of-eight turns of pelvis.

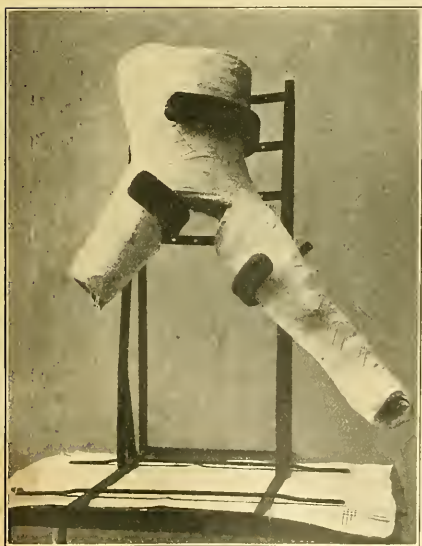


FIG. 667.—FRAME FOR UNILATERAL DISLOCATION (Heusser).



FIG. 668.—FRAME FOR BILATERAL DISLOCATION (Heusser).

The patient walks with the foot everted for from eighteen months to a year after the reduction has been accomplished. In some individual cases the

foot may be allowed to turn forward of its own accord, but in others it will be necessary to educate the patient to walk properly. When the surgeon is sure that



FIG. 669.—ACTIVE ABDUCTION FOR UNILATERAL DISLOCATION (Lorenz).



FIG. 670.—ACTIVE HYPERABDUCTION FOR BILATERAL DISLOCATION (Lorenz).

the reduction is secure, the foot may be permitted to assume its normal position approaching the frontal plane.

The full period of treatment by the Lorenz method would extend over a period of about two years, which would be the same as in the older traction

methods. But the great advantage of this method of treatment, the function-weight-bearing, is that the patient uses the limbs within two or three weeks after the reduction, and the restoration of the muscular power is more rapidly obtained.

Electricity is of no particular value as a part of the treatment, except where there has been an injury to the nerves.

The difficulties and dangers incident to the manual reduction of congenital



FIG. 671.—BILATERAL DISLOCATION. BACK VIEW.



FIG. 672.—BILATERAL DISLOCATION. SIDE VIEW.

dislocation of the hip are apt to be underestimated by the unskilful on account of the apparent simplicity of the operation in the hands of the skilful surgeon. That it should not be undertaken lightly is demonstrated by the number of accidents which have occurred even under skilful hands. Lorenz in 1900 reported 450 cases, with two deaths apparently due to the manipulation, in addition to which there were fractures of the femur and pelvic bones, and paralyses of the anterior crural and sciatic nerves, and one case of total gangrene of the lower extremity. Hoffa reported to the German Congress in 1899,

injuries to the soft parts, fractures, separation of the epiphyses, paralysis of the anterior crural and sciatic nerves, and suppuration of the hematomas at the seat of the ruptured adductors. He reports one death.

The fractures do not interfere with the recovery, and the paralysis of the anterior crural usually recovers within the period of the first dressing, or before the end of six months. In paralysis of the sciatic nerve and its branches the prognosis is more grave; and if it be due to rupture of the nerve, unless this



FIG. 673.—BILATERAL DISLOCATION, SHOWING RESULT OF OPERATION.

is repaired it may be permanent. As a rule, however, recovery from this condition ensues also.

In my own personal experience of quite a number of cases none of these accidents have occurred. But I have seen an instance of the obstruction of the venous circulation lasting for an hour, and also ankylosis and suppuration from the hematomas.

Lorenz reports 50 per cent. of functional cures by his method, and Hoffa claims 80 per cent. of successful results by his different methods of forcible reduction, and the open operation.

The method of Hoffa. This method is a modification of that of Lorenz. Hoffa, after the example of Kummel, omits all preliminary extension and begins directly with the abduction of the leg. With the patient in the recumbent position the leg is carried back—abducted at a right angle—and strongly rotated outward, to a horizontal position, toward the buttocks, the movement being that of a pump-handle; and at the same time gradual hyperextension is made upon the leg. In this way the acetabulum is thoroughly widened, and the spanning capsular wall is stretched. By this method reduction of congenital



FIG. 674.—FORCIBLE CORRECTION FOR CONGENITAL DISLOCATION (Hoffa). ABDUCTION.

dislocations has been accomplished in older subjects where the Lorenz method has not succeeded.

Another method employed by Hoffa is based upon the distinction recently made by Lorenz himself between a reposition by the “free-hand” or on the wedge-shaped block. In employing the free-hand procedure the pelvis is fixed by an assistant by pressing it firmly against the table. The operator then seizes the under end of the thigh—bent at a right angle and slightly rotated inward—with one hand, while with the thumb of the other hand pressure is

made upon the trochanter. With the hand holding the thigh a powerful pull is given toward the thigh, and perpendicular to the long axis of the body, median pressure being continued by the thumb upon the trochanter, and at the same time the leg is strongly abducted. After one or more repetitions of this movement the reposition is accomplished.

Mechanical Reduction.—In older subjects it is sometimes necessary to resort to mechanical aids to accomplish reduction in order to avoid fractures and injuries to the nerves and vessels. The most efficient apparatus of this

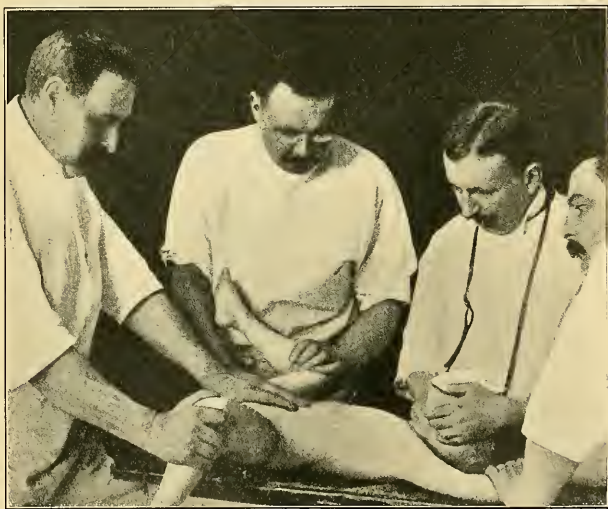


FIG. 675.—SAME AS FIG. 674; ROTATION OUTWARD.

kind is one devised by Mr. Ralph W. Bartlett, of Boston.* It consists essentially of a perineal plate, adjustable cylinders, and a traction rod, together with a side arm which makes pressure upon the trochanter in a forward and downward direction. Bradford and Lovett have reported a series of 30 cases in which the use of this apparatus has proved very efficient. It should be employed in cases of older persons, or which have been long resistant, since the ordinary methods of manipulation are entirely satisfactory in the milder forms.

* "Jour. of Med. Research," Dec., 1903, p. 440.

The gradual reduction of the dislocation by mechanical means is still employed by some surgeons, the apparatus of Schede representing the mechanical principles of this method.

Operative Methods Other Than Bloodless.—In subjects which are not suitable for the bloodless reduction certain surgical operations are of value. These include the following:

1. Tenotomy of the adductors:

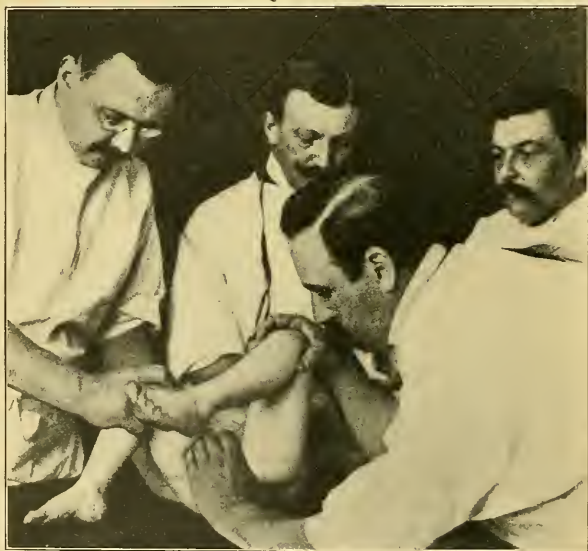


FIG. 676.—SAME AS FIG. 674; REDUCTION WITH WIDENING OF ACETABULUM.

2. Resection or decapitation of the femur.
3. Formation of a new articular cavity, or arthrotomy.
4. Osteotomy.

Tenotomy. In individuals who are too old for the bloodless reduction great benefit may often be derived from the free division of the adductor muscles and the use of a very long corset. Acting under the personal suggestion of Lorenz, the writer has employed this method with great satisfaction in patients over fifteen years of age, and considers it in many ways superior to the more

serious operations. It improves not only the position of the femur but reduces greatly the lordosis.

Resection or decapitation of the femur. The resection of the femur for the relief of this deformity, while it has been performed a number of times in the past, would not at the present time be considered, since the other methods are so much more satisfactory. The operation of decapitation of the femur in itself is not at the present time considered by surgeons except in adult cases.

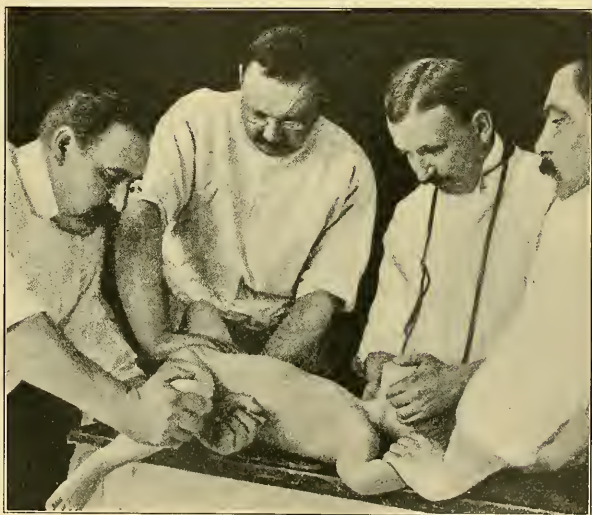


FIG. 677.—SAME AS FIG. 674; STRETCHING OF CAPSULE.

Together with the formation of a new articular cavity as performed by Hoffa, this operation will be considered in detail later.

Arthrotomy, or the formation of a new articular cavity. The method of operation as formerly performed by Hoffa consisted of a posterior incision and the division of all the trochanteric muscles. This extensive operation has since been replaced by the more simple method which is now employed by Hoffa.

After a period of preparation, about two weeks, in which extension has been applied to the limb, and in certain cases the adductors forcibly torn, the operation is undertaken, under aseptic precautions. An incision six inches in

length is made on the inner border of the tensor vaginæ femoris at the junction of the middle of the upper third of the thigh and is carried upward to the anterior superior border of the great trochanter. The fascia lata is incised and the muscles are carefully separated. While the limb is held in abduction a sectional division of the capsule is made upon its anterior surface, in the direction of the insertion of the femoral head into the pelvis. If this incision should not prove sufficient to permit the luxation of the head of the femur, another incision may be made at right angles to the first, thus making a T incision. A new cavity is then formed by excavating the old cavity by means of a Doyen borer, the excavation being deepest at its upper portion so as to prevent the slipping of

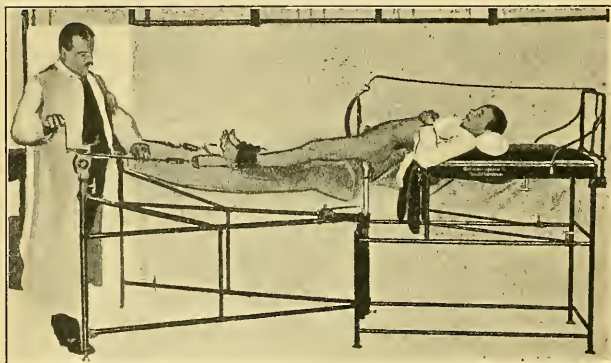


FIG. 678.—SCHEDE'S EXTENSION FOR DISLOCATION OF HIP.

the head. The femoral head is then put into place—a matter sometimes difficult in older patients—by the retraction of the capsule to its anterior surface, and by traction and abduction of the limb, the traction being made by means of windlass and folded sheets. The wound is then packed with a tampon of sterile gauze, and antiseptic dressing is applied and the limb fixed by the application of a plaster bandage, while the assistants make a contra-extension, and traction on the limb, together with abduction and slight inversion of the foot. The limbs may be held in fixation by means of an apparatus described by Hoffa or by the use of the Phelps bed. The patient should not walk until the cicatrix is entirely healed, which should be in about two weeks' time, and the cast may be removed at the end of three weeks. The gauze tampon should be

removed in about eight days after the operation, after which compresses are applied to either side of the wound, and the dressing of the wound is continued until it is healed. If any granulations occur, they should be removed by the use of caustic applications.

During a certain period of the immobilization of the hip passive movements are given, supplemented by massage.

This operation presents certain grave difficulties, especially when performed

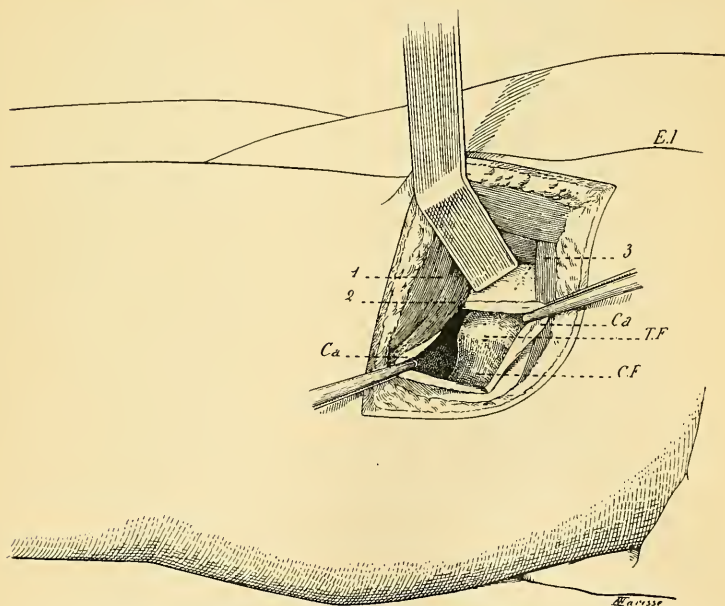


FIG. 679.—HOFFA OPERATION. INCISION OF CAPSULE (Berger and Banzet).

E.I., Poupart's ligament; 1, sartorius; 2, long head of biceps; 3, tensor vaginæ femoris; *Ca*, capsule; *C.F.*, neck of femur; *T.F.*, head of femur.

upon older patients, exposing them to the dangers of absolute or relative ankylosis, arrest of development, and contraction of the pelvis. There is usually a certain amount of shortening, which makes it particularly unsuitable for unilateral cases, and although there have frequently been very excellent results both anatomically and functionally, the operation has been abandoned by a great number of orthopedic surgeons.

In cases where neither the bloodless reduction nor the above mentioned

operation are suitable, where the patients are over ten years of age, or in bilateral cases, another operation is performed, which is known as pseudo-arthritis. An incision about four inches in length is made over and above the trochanter, exposing the capsule; the joint is opened and the head of the bone removed with a wide chisel. The capsule of the inner surface is divided longitudinally and a portion removed so that the exposed bone will fit into the cavity. The



FIG. 680.—RESULT OF OPEN OPERATION (Hoffa).
SIDE VIEW.



FIG. 681.—SAME, BACK VIEW.

adductors are divided by tenotomy. The wound is then packed with a tampon of sterile gauze, aseptic dressings applied, and a plaster bandage applied to fix the limbs, great care being taken to keep the limbs in their proper relation to each other so that there is no change in the angle which the femur makes with the pelvis on either side. Otherwise it would be necessary subsequently to do an osteotomy. The wounds should heal in about three weeks, and the cast may be removed at the end of six weeks.

In cases of patients over ten years of age this operation has given some very good results both anatomically and functionally, the patients being able after recovery from the operation to walk from five to ten miles without discomfort.

Osteotomy. In patients over ten years of age where there is marked deformity of the neck of the femur, and particularly in unilateral cases, the operation of subtrochanteric osteotomy offers the best chance of improving the condition. This is best performed by exposing the trochanter by a longitudinal incision over its outer border, passing retractors about its circumference and making the section with a broad chisel. This method of division of the bone is recommended because the joint is movable and there is great difficulty experienced in dividing the trochanter under these circumstances. It is quite easy to divide the trochanter where there is ankylosis, as in ankylosis of the hip from hip-joint disease. If the deformity of the neck amounts to coxa vara, a small wedge-shaped section may be removed from the trochanter and the limb dressed in a position of forced abduction, as has been recommended in the section on coxa vara. An operation of this character improves the position of the neck of the femur without the danger of ankylosis.

CONGENITAL DISLOCATION OF THE KNEE.

This condition, which is an exaggeration of congenital genu recurvatum, or back-knee, is comparatively rare. Of 11 observations made by Hibbon, 8 were normal in other respects and 3 were connected with other malformations, the former presenting unilateral and the latter bilateral dislocations. Keating mentions 49 cases collected from other writers, including dislocations of both sorts, to which Lovett has added three personal experiences and the writer two. Of 34 cases reported by Taylor; the deformity was bilateral in 18 and unilateral in 16. Twenty-four cases were reported as anterior, and of these, in one-half of the instances no patella could be felt at birth. Posterior dislocation is very rare. The condition is often found to follow breech presentations, although neither of the writer's cases were of this character.

Lateral mobility is the exception and, as a rule, is confined to bilateral cases where other deformities exist. In the writer's two cases there was no lateral mobility. Abduction with eversion is the direction in which mobility is most marked. In a case reported by Krönlein there was ankylosis with anterior luxation of both tibias. The cause is to be sought in some malposition

in intrauterine life or in some injury sustained at birth. Pathologically the condyle may be small or flattened, the patella rudimentally or entirely absent. A case



FIG. 682.—BILATERAL CONGENITAL DISLOCATION OF KNEES.



FIG. 683.—UNILATERAL CONGENITAL LUXATION OF LEFT TIBIA (Army Medical Museum).



FIG. 684.—SAME, SHOWING RESULT OF MANUAL REDUCTION.

of Albert's showed the vessels lying behind the outer condyle of the femur, and a bilateral case of Wolff's showed the luxation of one knee only to be permanent.

The treatment of congenital dislocation of the knee can generally be successfully accomplished by manipulation and the use of braces. In the writer's opinion the best mode of treatment is the use of plaster-of-Paris casts, changing them from time to time as the correction of the affected part advances.

In a case of the posterior variety reported by Hamilton the hamstrings were divided and reduction made. A similar instance is reported by Sayre in Mason's case.

In the case of forward dislocation operation is seldom desirable. The writer would suggest subcutaneous division of the rectus tendon. Wolff gives an instance of having operated for forward dislocation, and manual osteoclasis of the lower end of the femur has been reported by Phocas. Taylor reported a case which showed good results from braces worn three years.

CONGENITAL DISLOCATION OF THE SHOULDER.

The rarity of congenital dislocation of the shoulder is shown by the statistics of Krönlein from Langenbeck's clinic. His report included ninety-eight cases of various congenital dislocations, and of these, only five were of the shoulder. In the majority of cases the position of the head is usually subspinous; it may, however, be supra-acromial or subcoracoid. In the subspinous cases the head of the humerus is just posterior to the normal situation of the glenoid fossa, below the junction of the acromion process with the spine of the scapula.

Under the term congenital dislocation may be included displacements due to the following causes: (1) Anatomic changes either in the head of the humerus or the glenoid cavity of the scapula. In this class there may be other congenital deformities, the lesion may be double, or there may be marked shortening in all the bones of the extremity. (2) The dislocation may be caused by a lax condition of the capsule as a result of paralysis. In these cases there is no deformity of the bony structures and the dislocation may have taken place during labor or at a previous time. (3) The dislocation may be due to violence during delivery. In this class the articular structures are normal.

Symptoms.—In most cases the condition is not recognized for some time after birth. As the great majority are of the subspinous variety, the arm is usually abducted and rotated inward, while the head of the bone is felt in its abnormal position. There is generally limitation of motion and atrophy of the muscles above the shoulder. In the class of cases that may be considered purely congenital Porter states that there was, without the slightest doubt, a

difference in the measurements between all the bones of the affected extremities in his cases. He is upheld in this statement by Scudder and Stimpson. There is usually inability to put the hand to the mouth, and in some cases it is impossible to carry the hand forward and turn it over.

Phelps found in all his cases a fracture of the posterior border of the glenoid cavity. In several the posterior rim of the glenoid cavity had been carried backward, but was still attached to the capsule. In all the cases the glenoid cavity was semilunar in shape.

Diagnosis.—The two forms, the one due to imperfect development and the traumatic variety, are very often hard to differentiate unless the joint is opened. This is especially so as it is difficult to palpate the deep structures of the joint with sufficient accuracy to determine the form. In those due to imperfect development of the articular structures there coexists a similar lack of development in all the parts of the extremity, as pointed out by Scudder and Porter. The condition is often confused with obstetric paralysis. They resemble each other only in the position in which the extremity is held. In obstetric paralysis careful examination will show the absence of a dislocation. Separation of the epiphysis of the humerus occurring during delivery may resemble dislocation, but will be readily recognized by the *x*-ray examination.

Many cases of so-called obstetric paralysis are originally dislocations which have remained unreduced. Continued pressure of the head of the humerus on the brachial plexus in cases of congenital dislocation in time produces a paralysis, which, combined with the deformity present in dislocation, often gives the picture of obstetric paralysis. The author has recently reduced one of these dislocations eight months after birth, with perfect restoration of function.

Treatment.—This consists in reduction, if possible, as soon as seen. Different methods must be used in treating the form due to imperfect development and that due to traumatism. In those cases due to imperfect development the best results are offered by an early operation before the changes in the glenoid cavity have taken place. A number of cases have been reported but no treatment offered. In the traumatic variety treatment is followed by good results. In these cases either bloodless reduction or operative interference may be used. Whitman suggests that treatment similar to that used in congenital displacements of the hip is successful. He has been able by means of prolonged forcible manual stretching to relax the contracted parts sufficiently to reduce two cases by manipulation. The parts then are to be placed in plaster-of-Paris for several months. The limb should be extended on the scapula, thus forcing the head

of the humerus into its proper place, and it should be rotated outward to overcome the inward rotation. The parts should be fixed for several months, after which massage, passive motion, and electricity may be instituted. In case of recurrence the joint may be opened and attempts made to bring the parts together, or the articulating cartilages may be removed in the hope of obtaining ankylosis.

Phelps has seen eight cases of congenital dislocation of the shoulder; four of them were operated on, and the other four were reduced under anesthesia. In three of the operated cases the deformity has recurred; in the fourth the head of the humerus was in a better position and there was fifteen to twenty degrees of passive motion possible. Of the four reduced under anesthesia, all were under one year of age and had done well. In one of Phelps' cases he opened the joint by a posterior incision along the border of the deltoid muscle, and found the atrophy of the scapula and a portion of the edge of the glenoid cavity broken away. There was marked contraction of the structures on the anterior aspect of the joint, compelling him to cut away a portion of the head of the humerus to reduce the dislocation. The false cavity and a portion of the capsule were also removed. He states that the result was very good.

At present our knowledge of the pathology and causation of the condition is not sufficient to establish a successful method of treatment.

Porter reviews the literature of the subject and the reports on twenty-nine cases. The results of treatment are for the most part unsatisfactory, recurrence being frequent.

CONGENITAL DISLOCATIONS OF THE ELBOW.

Congenital dislocations of the ulna and radius are very rare, and while some cases have been reported they are for the most part of little practical importance. They may be due to a lax condition of the ligaments, to imperfect development of the condyles or coronoid or olecranon processes, to lack of development of the radial articulation of the humerus, the head of the radius or articular cartilage. The condition is at times accompanied by other congenital malformations, and is often bilateral. Ronnenberg collected 31 cases from the literature of the subject, and in a number he found a history of heredity. The radius is most frequently dislocated, and in some instances there is also a dislocation of the ulna.

The dislocations may be divided into the following classes: (1) Dislocation

of both radius and ulna backward; (2) dislocation of the radius forward and upward; (3) complete dislocation of the radius backward with partial dislocation of the ulna backward. In this class the coronoid process or the external condyle is usually undeveloped.

Very often the condition is not accompanied by any disability. At times supination is diminished on account of the comparative length of the radius. In most cases there are no subjective symptoms. In dislocation of the radius causing disability benefit may be obtained by resection of the head of the radius. Most cases, however, require no treatment.

CHAPTER XXX.

PERVERTED DEVELOPMENT.

The number of congenital deformities dependent upon perverted development is very large, but some of these have been omitted altogether; others belong more properly to works upon teratology, and only three need here be described—club-hand, deformities of fingers and toes, and deficiency of parts.

Club-hand.

Club-hand includes any deviation of the hand from its normal relation to the forearm at the wrist.

Synonyms.—*French*, Main-bote. *German*, Klumphand.

The deformity may be in the direction of—(1) flexion, or palmar, (2) extension, or dorsal, (3) adduction, or radial, (4) abduction, ulnar or cubital, or any combination of these, as radio-palmar, radio-dorsal, cubito-palmar, and cubito-dorsal.

The affection is generally congenital, but may be acquired. One or both hands may be affected.

The flexion forms are most common, and the deformity is usually associated with other malformations.

The congenital varieties occur in all four forms, the flexion and extension being most common without the absence of bones, and the lateral deformities being usually associated with an absence of the radius or ulna. The adduction or radial form is most common, in which respect it corresponds to the greater frequency of congenital absence of the fibula. Of the cases reported by Hoffa, thirty-nine were radial and six were ulnar.

Etiology.—The cause is obscure, but may be accounted for in congenital cases by the pressure theory of absence or deficiency of liquor amnii, and where there is associated deficiency of bones, by the theory of attachment of the amnion to the skin while these parts were in contact in early embryologic life. A rare cause from cerebral injury has been reported by the writer. The acquired variety may result from nerve irritation from bullets, tumors, bone, or as sequels of burns and scalds.

Symptoms.—The hand is not rigidly held in the deformed position, but admits of a certain range of motion, beyond which it is checked by the shortened muscles or bony changes. The diagnosis is made upon inspection. In all cases where it is possible a skiagraph of the deformity should be taken, as it is often impossible to determine the exact amount of bony deficiency without this aid. The possibilities of recovery without treatment are slight.

Treatment.—In mild congenital cases manipulation and the use of a pressure bandage will accomplish a cure, as in the case reported by Piéchaud, of a child with double club-hand of the ulnar variety, cured by the mother's manipulation in five months.

Plaster-of-Paris bandages have been successfully employed. In the severer forms tenotomy will be indicated, the tendons requiring division being generally the palmaris longus, flexor carpi ulnaris, and flexor carpi radialis. The possibilities of ununited tendon after tenotomy are greater in this region than elsewhere, and in most cases where practicable the tendon should be lengthened by the modern method of open incision, identical with Willett's operation in the foot. An operation of this character upon a young woman suffering from monoplegia by the writer proved eminently successful.

In cases due to severe irritation the removal of the cause will accomplish a cure, and in paralytic cases the use of suitable mechanical appliances should be assisted by massage and electricity. Where there is congenital absence of the epiphysis of the radius or ulna, an attempt may be made to correct the deformity by excision of the epiphysis which is normal in order to destroy the growth of the part.

Operations on the bones are sometimes undertaken for the correction of club-hand. Bardenheuer split the distal end of the ulna longitudinally and fixed the ends to the carpal bones with an ivory peg upon each side. The result was reported good. Subsequently McCurdy obtained a good result in a case of palmar club-hand by dividing the ulnar bone. Through an oblique incision across the forearm the ulna was divided so that the upper fragment was brought into contact with the semilunar bone, to which it was sutured.

Deformities of the Fingers and Toes.

The congenital deformities of the fingers consist of six classes: supernumerary fingers and toes, congenital deficiencies, congenital union, hypertrophy, deviations, contraction, and tumors.

Supernumerary fingers and toes, known also as **polydactylism**, is not an

uncommon inheritance in some families. It may recur in every generation, or one or more generations may escape this deformity. It may be unilateral, but as a rule is bilateral, there being usually one additional member on each hand and foot. This number may be greatly exceeded, as in the cases of Saviard and Voigt, which had respectively ten and thirteen fingers and toes on each hand and foot, or the case of Bradford and Lovett, which had fifteen fingers and ten toes. The additional parts are usually added upon the ulnar side of the hand. Some are fully formed, but more often they are imperfect and associated with other deformity, especially congenital union.

The proper treatment consists in the removal of the supernumerary parts, and this can be accomplished with perfect safety at two or three months after birth. In exceptional cases the amputated part may be perfectly reproduced,



FIG. 685.—LOBSTER CLAW DEFORMITY OF HAND.

as in the remarkable case of White,* where a supernumerary thumb was twice entirely reproduced.

Congenital deficiencies, or **ectrodactylisms**, either in the number or bulk of digits, are not common, and when they do occur are usually the result of amniotic inflammatory adhesion or amputation, not hereditary, but the result of maternal impression. All the fingers of one or both hands may be wanting.

Lobster-claw.—A peculiar absence of the fingers with deformity has been described by Tubby, Emil Haim, and others, and from its resemblance to the claw of a lobster it has been distinguished as the “lobster-claw” deformity—the *spaltfuss* and *spalthand* of the Germans. During the winter of 1904-1905 I had an opportunity of studying a family affected in this manner who were residing in Philadelphia. It is usually a hereditary affection, the case described

* C. White : “On the Regeneration of Animal Substances.”

by Tubby having been traced through the family for several generations. All of the members of the family presented abnormalities of hands and feet. The deformities in families so afflicted are not always uniform. In the family which came under my observation the cases appeared to have been sporadic, the ancestors not being affected. Of the immediate family, the first two children were normal, the third deformed, the fourth normal, and the two succeeding

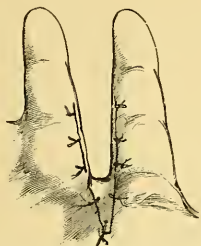


FIG. 686.—VELPEAU OPERATION.
Dorsal flap brought through between fingers and stretched on the palmar side; also wound closed on opposite side of fingers (Agnew).



FIG. 687.—FORM OF INCISION FOR WEBBED FINGERS IN VELPEAU OPERATION (Agnew).



FIG. 688.—DIDOT'S OPERATION FOR SYNDACTYLISM, REPRESENTED IN CROSS-SECTION (Bradford and Lovett).

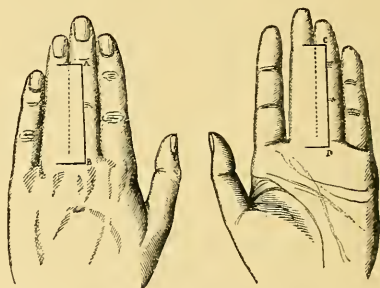


FIG. 689.—DIDOT'S OPERATION FOR SYNDACTYLISM (Bradford and Lovett).
A, B, Dorsal flap; C, D, palmar flap.

ones deformed. In Haim's case the grandfather, the mother, and the child were all similarly affected.

The deformity consists in the absence or suppression of the second, third, and fourth fingers, the thumb usually being longer than normal and hypertrophied, and the little finger is also apt to be over-developed. Between the thumb and the little finger there is a wide gap from the loss of the fingers and metacarpal bones. The carpal and dorsal bones are usually present, as shown

by the skiagraph, and the metacarpal bone may be bifurcated or may be deviated laterally, and the bifurcation may be marked by an exostosis. Males appear

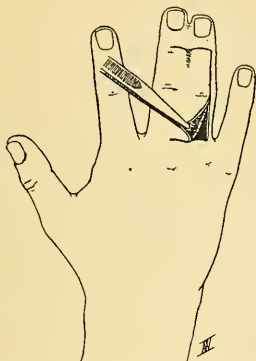


FIG. 690.—DISSECTION OF THE DORSAL STRIP OF SKIN. OPERATION OF FORGUE FOR WEBBED FINGERS.

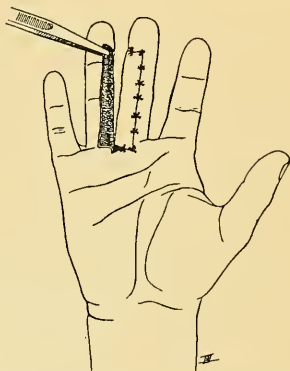


FIG. 691.—APPLICATION OF THE DORSAL STRIP TO THE INTERNAL AND PALMAR SURFACES OF THE MIDDLE FINGER.

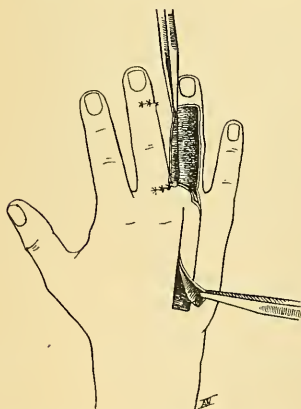


FIG. 692.—DISSECTION OF A STRIP TO RE-COVER THE EXTERNAL AND DORSAL SURFACES OF THE THIRD FINGER. FORGUE OPERATION FOR SYNDACTYLISM.

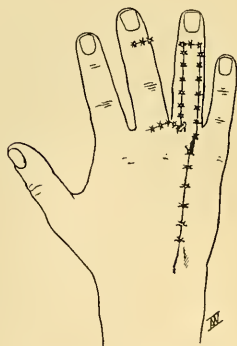


FIG. 693.—RESULT OF THE OPERATION.

to be more frequently affected than females and the deformity appears, as a rule, to be transmitted through the males.

The lobster-claw deformity sometimes exists in the foot, the second, third,

and fourth toes being absent, the great toe and little toes being over-developed, as in the hand. When the deformity is very severe, it interferes with locomotion, but where it is not severe the shoe conceals it, and if there is no similar affection of the hands it passes unnoticed.

The treatment is limited to the separation of webbed fingers, or plastic operations to restore deficient parts.

Congenital union, or webbed fingers and toes, scientifically known as **syndactylism**, is common, and may involve the union of the digits throughout their whole length or only the terminal phalanges.

The united parts may be divided by a simple incision, and the parts held apart by strips of oiled lint until cicatrization is complete, but the plastic operations of



FIG. 604.—CONGENITAL HYPERTROPHY OF FINGERS (Morton).



FIG. 605.—CONGENITAL HYPERTROPHY OF FINGERS (Jones).

Velpeau or Didot or Forgue are more satisfactory. Velpeau's operation consists of a V-shaped flap cut from the dorsal surface of the base of the web, with the apex anterior, extending through one-half of the thickness of the band. This flap is dissected back, the remaining portions of the web slit longitudinally, the flap drawn through the cleft at the base of the fingers, its apex stitched to the palmar surface of the wound, and its sides to the sides of the fingers.

Didot's operation consists of a palmar flap from one finger and a dorsal flap from the adjoining one, the flaps extending to the middle of the fingers. The remaining web is divided and the dorsal flap of one covers the palmar



FIG. 696.—SKIAGRAPH OF HYPERTROPHY OF FINGER (Jones).

surface of the other. Separation of webbed toes is not so often demanded, since the deformity is easily concealed, but when necessary it should be performed by the same methods as for webbed fingers.

Forgue has modified the operation of Velpeau by dissecting a flap from the dorsum of the hand, with the base toward the finger, over the metacarpal bone of the denuded finger, and suturing it to the external and dorsal surfaces of the denuded finger.

Hypertrophy of the fingers and toes usually affects but one or two digits. Some of the cases formerly classed under this head belong more properly under akromegaly. Sometimes the hypertrophy of the fingers and toes is com-



FIG. 697.—CONGENITAL HYPERTROPHY OF TOES (Shoemaker).

posed of the soft parts only, but in others there is present a hypertrophy of the osseous structures as well. The treatment demanded is amputation.

Congenital contraction of the fingers and toes is, in some cases, hereditary, and is usually the result of defect or deficiency of the bones or contracture of the fascias and muscles.

The contractions of the toes have already been described, and there remain only the congenital contraction of the finger, the contraction of the palmar fascia, or Dupuytren's contraction, trigger-finger, and mallet-finger.

Congenital Contraction of the Fingers.—This affection consists of a contraction of the little finger, and sometimes the ring-finger, and in very

exceptional instances all of the fingers may be contracted. This deformity is hereditary, and differs from Dupuytren's contraction in that the contraction is limited to the fascias and tendons of the finger and does not involve the palmar fascia. Three stages have been described—the mild, medium, and severe forms. In the severe form a thickened fascia may be felt on the palmar surface of the fingers. The treatment consists in the manipulation of the part in mild cases and in division of the fascias in severe cases.

Dupuytren's Contraction. **Synonyms:**—*French*, La Contraction des Doigts; La Maladie de Dupuytren. *German*, Die Dupuytren'sche Kontraktur der Finger.

Dupuytren's contraction is a name applied to a contraction of the palmar fascia or its digital prolongation producing permanent flexion of one or more of the fingers. This condition had been described prior to Dupuytren, but he was the first to demonstrate clearly its pathology by careful dissection of a hand he was fortunate enough to possess.

The cause of this disease has never been satisfactorily explained. Two theories account for the major part of the cases—the influence of long-continued slight traumatism, and of a rheumatic or gouty diathesis. Syphilis is undoubtedly an occasional factor in the causation, and recently Abbe has advanced a theory of central nervous irritation producing nutritive changes in the affected hand.

In Keen's recorded seventy-two cases, only eighteen were among the laboring classes. This, together with the fact that the left hand is as frequently involved as the right, and that the ring and little fingers are most commonly affected, while certainly they are not the most exposed, sufficiently explodes the theory of traumatism. On the other hand, there are few American families in whom it is not possible to find a rheumatic member.

The deformity is caused by a scar-like contraction of the palmar fascia and the areolar network overlying it, by means of which the digital prolongations of the fascia are retracted and the fingers flexed into the palm. The tendons lying below the fascia remain free and uninvolved. Along the course of the contraction small hard bodies are found, which upon examination prove to be small fibromas. The skin, if affected at all, is only so late in the disease.

The first sign is a small body, the size of a shot, appearing in the metacarpal phalangeal crease, with some stiffness of the ring or little finger. This is entirely painless. After some months or years a cord is noticed running to these fingers, which are contracting into the palm.

The forced flexion of the fingers, the fact that ankylosis of the joints does not exist, the absence of pain, the advanced age of the patient, the non-existence of cerebral or spinal disease, or of injury to the part, with loss of substance followed by a scar-like contraction, present so clear a clinical picture that the diagnosis cannot easily be mistaken.

The only condition from which this deformity should be distinguished is congenital contraction of the fingers. From this condition it differs in the following points: Congenital contraction of the fingers occurs in early life, whereas Dupuytren's contraction occurs in late life. Congenital contraction is more frequent in females, while Dupuytren's contraction is more frequent in males. In congenital contraction the fascias of the fingers only are involved, and in Dupuytren's contraction the palmar fascia only is involved. In congenital contraction the first phalanx is hyperextended while the second and third are flexed, and in Dupuytren's contraction the third is generally hyperextended while the first and third are flexed.

An absolutely favorable prognosis can be given if an operation is allowed. The condition is not easily corrected without it.

The medicinal treatment is *nil* except when there is a syphilitic taint, when iodids should be freely used with prospects of cure, as in the successful cases recorded by Richet and Ricord. The mechanical treatment has been abandoned for the surgical, which consists of either a subcutaneous incision of the fibrous bands, or an open one, with or without removal of part of the contracting tissue. A small pointed tenotome should be inserted a little to one side of the cord and the fascia cut down upon. This is repeated in several places until the fingers can be partially straightened. Dupuytren's original operation of open transverse incision through the band in its two or three most prominent places is still practised, or the skin may be reflected in a V-shaped flap and the contracting material dissected out. A curved splint should be applied for the first few days, after which time it may be replaced by a straight one, to be worn for two or three weeks. Ether need not be used, cocain anesthesia (2 per cent. solution) being sufficient.

Trigger-finger.—(*Synonyms*, Snap-, jerk-, or spring-finger.) Trigger-finger consists in the permanent flexion of one finger when the others are extended. The contraction of the finger may be overcome by a greater voluntary effort, when it usually flies backward suddenly with a snap to the extended position, from which characteristic it has derived its names. The thumb, middle, and ring fingers are the ones most frequently affected. The cause of

the affection is some interference with the free motion of the tendon as it passes through its sheath or through a groove, the difficulty being due either to an expansion or thickening of the tendon or to a narrowing of the groove. Sometimes the obstruction is a small, hard, rough body smaller than a pea and attached to the deep structures in the vicinity of the sheath of the flexor tendon of the thumb or index-finger. Small ganglia have also been discovered upon the flexor tendons. The treatment consists in the excision of the ganglion if it can be detected. The inflammation of the fascia requires counter-irritation with iodine or the Paquelin cautery.

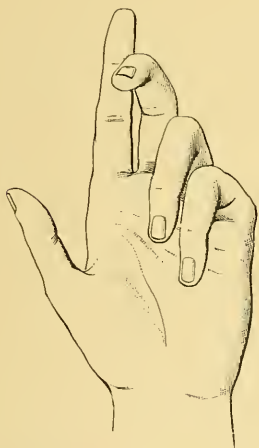


FIG. 698.—DUPUYTREN'S FINGER CONTRACTION (Ashhurst).



FIG. 699.—THE SAME HAND AFTER OPERATION (Ashhurst).

Mallet-finger.—(*Synonym*, Drop-finger.) This deformity consists in the flexion of one finger when the others are fully extended, and is usually the result of injuries received in athletic sports, and is caused by the rupture or detachment of the fibers of the ligament on the posterior surface of the distal phalangeal joint. It is very common among baseball-players. The injury which produces the deformity is frequently very slight. Immediately following the injury there is sometimes discoloration, slight swelling over the last joint, with a tender area on the posterior surface of the last phalanx. The treatment consists in fixing the finger in full extension upon a metal splint. If this method of treatment does not effect a cure, in two weeks an incision should be made, linear in character,

in such a manner as to expose the torn fasciculi. These may then be sutured into the skin or the periosteum, preferably the latter, and the deformity be slightly over-corrected and the finger fixed with a splint.

Congenital tumors of the fingers and toes have been grouped by



FIG. 700.—SKIAGRAPH OF CONGENITAL TUMOR OF FOOT (Spellissy).

Annandale into four classes: (1) pedunculated growths or excrescences of the skin, (2) fatty growths, (3) fibrous growths, and (4) cartilaginous growths.

The treatment consists in removal of the growths, those of the first class being removed early, and those of the other groups being permitted to remain until the period of infancy is passed.

Congenital Deficiency of Parts.

Congenital deficiencies vary in extent from the absence of a single digit to the entire lack of one or more extremities. They may be classed under two heads: Complete or partial absence of the part, and diminution in size, the part being perfectly formed. The total absence of both upper and lower extremities is an exceedingly rare malformation. In all the systematic works, upon teratology reference is made to this deformity, and cases have been reported by Hare and Hardy. Entire absence of both upper extremities has been observed by a number of surgeons, and the writer has observed two

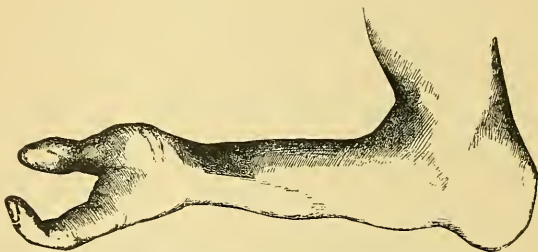


FIG. 701.—CONGENITAL ABSENCE OF ULNA. RIGHT ARM (Roberts).



FIG. 702.—CONGENITAL ABSENCE OF ULNA. LEFT ARM (Roberts).

unrecorded cases, one an artist familiar to many for his reproductions of paintings in the modern gallery in Antwerp, Belgium, and the other an inmate of the Philadelphia Almshouse, the proud father of a large family. In such cases the feet acquire great tact and skill and fulfil the offices of the hands.

Entire absence of the lower extremities is very rare also, and the accompanying illustrations of Shoemaker's case* show an excellent example of this type (Figs. 705 and 706). Partial deficiencies are much more common, and many cases of this character are recorded.

* "Trans. Coll. Phys. Philadelphia," 1892, p. 191. "Internat. Med. Mag.," March, 1893.

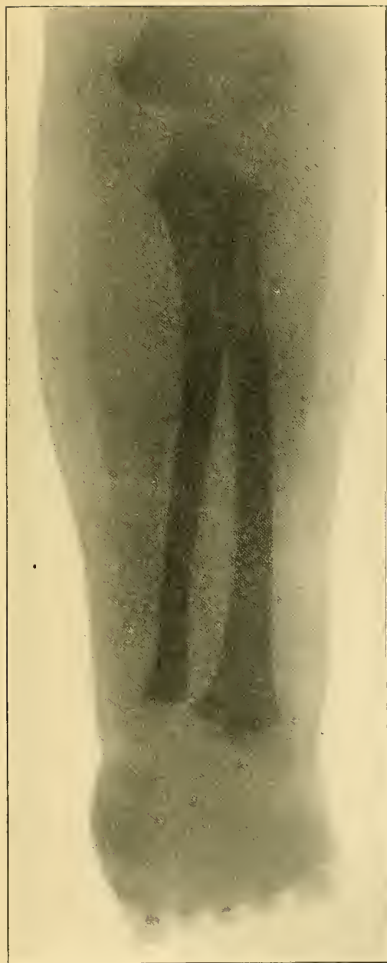


FIG. 703.—CONGENITAL ABSENCE OF CARPAL AND METACARPAL BONES.

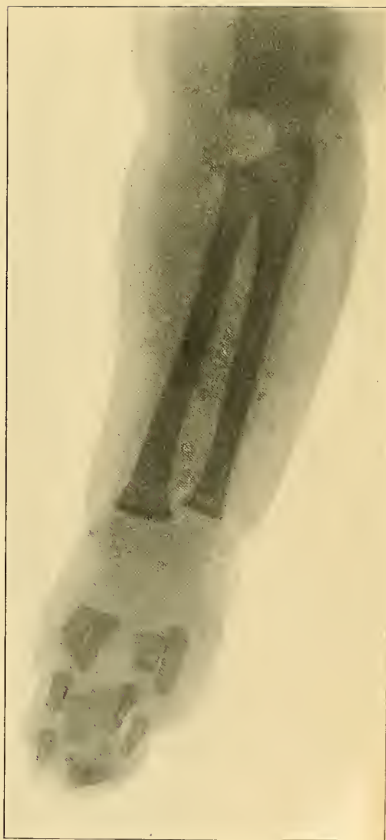


FIG. 704.—CONGENITAL DEFICIENCY OF HAND.



FIG. 705.—CONGENITAL DEFICIENCY OF EXTREMITIES. SITTING POSITION (Shoemaker).



FIG. 706.—CONGENITAL DEFICIENCY OF EXTREMITIES. POSITION ASSUMED WHEN WALKING ON HANDS.



FIG. 707.—AUTHOR'S CASE OF DOUBLE CONGENITAL ABSENCE OF TIBIA.

Of absence of the humerus, partial or complete, no cases are found in literature, but of all the other bones the number is very large. Compared with congenital absence of the ulna, the absence of the radius is quite common. Absence or defect of the femur has been observed many times, and Meyersohn has collected eighteen cases of fibular defect. Congenital absence of the tibia has received more attention and study than any other similar deformity, and for a full description of this remarkable malformation the reader is referred to the recent monograph of the writer,* in which four cases are



FIG. 708.—SINGLE CONGENITAL ABSENCE OF THE TIBIA (Ehrich).



FIG. 709.—CONGENITAL DEFICIENCY OF FEMUR.

recorded, together with a complete bibliography of the forty-eight cases abstracted from literature.

These cases attract the greatest interest from an orthopedic standpoint on account of the associated club-foot, and are the only ones demanding extended description.

* "Univ. Pa. Med. Bull.," Nov., 1904.

Etiology.—The study of the cause of congenital absence of the bones reveals much that is mysterious, hypothetical, and unexplained, from the fact that no pathologic specimens have been examined which exhibit the exact production of this deformity. Hence numerous theories have been advanced from time to time to account for the deformity. It has been attributed to heredity, pre-natal disease, arrest of development, mechanical pressure, and to amniotic adhesions.



FIG. 710.—HIGH SHOE FOR CASE OF CONGENITAL DEFICIENCY OF FEMUR.



FIG. 711.—CONGENITAL DEFICIENCY OF EXTREMITIES. PERMANENT APPARATUS APPLIED.

It is now generally admitted by authorities that the cause of congenital absence of parts is an amniotic adhesion. The occurrence of amniotitis has been doubted by some authorities. When the exact mode of the origin of the amnion is explained, the whole subject of the development of teratologic anomalies will be illumined. Enough is understood to explain the process of formation of amniotic bands resulting in fetal amputation, adhesions between the amnion and fetal parts, and to indicate that inflammation of the membrane is possible. The contact of the amnion with parts of the fetus results in adhesions, while the subsequent increase of fluid results in the formation of bands, cords, or in the destruction and absorption of the attached parts.

After the attachment of the part to the amnion the inflammation present produces an acute polyhydramnios, which, making traction upon the attached portion of the amnion, pulls the skin and the underlying structures from their places, separating them from their vascular and nervous connections, or, by the formation of amniotic bands, cutting them off entirely and producing their absorption.

From a careful examination of the cases coming under my personal observation and from a thorough investigation of the literature upon this interesting subject I am of the opinion that congenital absence of the bones is not teratogenic but that it is due to amniotic adhesions resulting from traumatism, slight in character, and occurring usually about the third month of fetal life.

In reference to the marked club-foot present in all these cases, the absence of the internal condyle and the unopposed action of the adductors are sufficient explanation, to my mind, for this deformity. That they were not the result of deficiency of liquor amnii and intrauterine pressure is clearly proved by the absence of pressure marks on other parts; the rare association of club-hand, the fact that no appreciable diminution in the quantity of liquor amnii was observed in these cases over previous or subsequent labors, but more particularly by the case recently observed of double equino-varus in a twin, the other child showing no deformity whatever.

The **treatment** will depend on the degree of deformity and the inconvenience caused by it, and upon the condition of the bones. In rudimentary femur an artificial limb with a trigger-lock at the knee gave satisfaction. Amputations at the knee were performed in a number of instances for absence of the tibia. Albert preferred a more conservative method, and performed an intercondyloid resection of a wedge-shaped piece, so that the fibula would come more directly in the line of support. Tenotomy and the use of an apparatus may suffice to bring the foot into an improved position. In bilateral absence of the tibia if the fibulas be normal, amputation should be deferred as long as possible, and tenotomies and braces should be employed, since in Parker's case the patient, in whom the deformity was bilateral, was able at three years of age to support himself and walk upon the fibulas.

CHAPTER XXXI.

ACCIDENT OR TRAUMATISM.

Many chronic conditions the result of accident or traumatism come under the care of the orthopedic surgeon. The distinction between orthopedic and general surgery is here very narrow, and is often a matter of chronicity rather than any other consideration.

These include dislocations of tendons and cartilage, and irreducible dislocation of bones, ununited fracture producing deformity, and rupture of muscular tissue and tendons, together with a brief consideration of the contractures and ankylosis which frequently result from injury or disease.

Dislocation of Tendons.

Dislocations of the tendons as a result of traumatism are most common in the long head of the biceps, the peroneal tendons, the posterior tibial tendon, and the latissimus dorsi.

The long head of the biceps may be displaced from the bicipital groove by violence. It is easily recognized, but the injury is not frequently met with, since rupture of this tendon is more apt to occur. The tendon should be replaced and the arm held in a Velpeau position and secured with a bandage. If repeated dislocations occur, operation may be undertaken to secure the tendon in the groove by a plastic or osteoplastic flap, or it may be sutured into place with silk.

Dislocation of the peroneal tendon has already been referred to in connection with the paralytic calcaneus. The peroneus longus and brevis may either or both be dislocated forward in front of the external malleolus, or the peroneus tertius may be displaced from its normal position and be recognized as a round cord on the dorsum of the foot. The treatment consists in replacing the tendon and securing it in an artificial groove by means of silk sutures, or an osteoplastic flap made for the reception of the tendon.

The tibialis posticus tendon may be dislocated forward so that it lies in front of the internal malleolus, cases of this kind having been reported. The accident is a rare one on account of the anatomic advantages of the internal ankle and

the secure position of this tendon. It should be reduced and retained in position by adhesive plaster and a cast. Its reduction is usually permanent.

The latissimus dorsi tendon may be torn from its position at the lower angle of the scapula, producing a displacement of the scapula, sometimes resembling incipient scoliosis. A depression is noticed beneath the lower angle of the scapula and the shoulder cannot be held in its proper position by voluntary effort. The treatment consists in making an incision over the inferior angle of the scapula and attaching the fibrous tendon of the latissimus dorsi to the scapula by silk sutures. A heavy pad should be placed over the scapula and the arm should be secured to the side by a plaster-of-Paris bandage.

Dislocation of Cartilage.

Under dislocation of cartilage should be considered dislocation of the semilunar cartilage of the knee and diastasis of the epiphysis of the tibia. The former has already been described in its proper place.

Diastasis.—Diastasis is a separation, pathologic or spontaneous, of the epiphysis from the diaphysis. It is also known as separation at the epiphyseal juncture.

Diastasis is an affection of youth and early adult life, and occurs usually as the result of direct violence, but may occur from indirect violence or an inflammatory process taking place at the epiphysis. One of the best examples of diastasis occurs between the first and second portions of the sternum, this region being also the seat of true dislocation, a true joint having been observed in this situation.

True diastasis as the result of disease or traumatism may occur in any part of the skeleton, but in this connection only those which resemble or complicate joint disease in the extremities will be considered. The most common seats are the upper part of the femur, the upper part of the humerus, the lower part of the humerus, and the upper part of the tibia.

In some cases the epiphysis is pushed off by granulations, and in the case of the upper part of the femur the head of the bone may be found loose in the cavity of the joint. More frequently it results from direct or indirect traumatism, in the reduction of dislocations, of ankylosis, and in the correction of rachitic deformities by manual or instrumental means. Epiphyseal separation of the humerus is occasionally seen in the newborn as a result of traction upon the arm. It is most frequently seen between the tenth and fifteenth year.

Agnew, Barwell, Marsh, and others refer to this accident, and Hamilton

refers to three cases recorded by South, Parker, and Post. Separation of the head of the tibia has been recorded. Epiphyseal separation occurs most frequently at the upper end of the humerus. In 49 cases reported by v. Bruns the upper end of the humerus was involved in 21 instances.

The separation always takes place between the shaft and the cartilage, exposing the upper end of the shaft or nodular surface. Rupture of the periosteum is not always complete, and very often there is a small fragment of the shaft torn off with the cartilage and epiphysis.

Following accident or disease in a young individual there is immediate shortening, with great mobility and soft cartilaginous crepitus, and flexion and rotation of the joint occasion no inconvenience. Severe inflammation may follow this ac-

cident, and swelling, redness, heat, and pain are followed by abscess formation and sinuses. Union is delayed, bony union may never occur, and shortening is an almost constant sequela.

Suspected epiphyseal fractures should receive very careful attention, as they are frequently overlooked, especially in the young. This is most marked in epiphyseal separation of the upper end of the femur (*coxa vara traumatica*), where very often there are no definite symptoms until deformity becomes well marked. Diastasis has to be distinguished from shortening of the limb from joint disease. This may readily be done by observ-

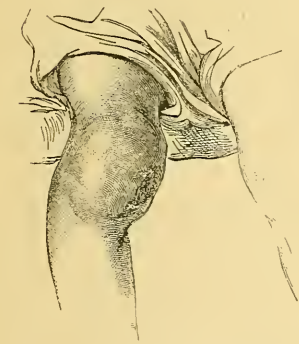


FIG. 712.—DIASTASIS FROM CARIES NECROTICA OF TIBIA (Barwell).

ing that the shortening in diastasis occurs suddenly in the young, whereas in coxalgia, knee-joint disease, etc., it is a late event in the disease, and there are present the symptoms of articular disease. An examination by the x -ray should always be made to confirm the diagnosis.

When this accident occurs during attempts to correct ankylosis, or rachitic deformities, the use of a plaster cast in the most favorable position will be advisable. The surgeon should bear this accident in mind during all orthopedic manipulations, especially during the correction of rachitic curvatures by osteoclasis or *brisement forcé*.

Irreducible Dislocations of Articulations.

In this connection the subject of irreducible dislocations will be considered only as it applies to orthopedic surgery. A dislocation would be considered an

old and unreduced dislocation if it remained luxated for one or two months after the injury. The term irreducible is frequently a misnomer, since if one method of reduction fails it may often be accomplished by a different form of manipulation.

Diagnosis.—The most important consideration in regard to these dislocations is to make a correct diagnosis, and this can often be accomplished only by means of a skiagram. The examination of the part in all its different relations should be carefully made, and after the patient has been anesthetized the skiagram should be consulted during the manipulation of the part. Many dislocations are complicated by fractures in their vicinity, and in all instances the previous history of the individual as regards injury should be considered, and a careful comparison of the injured part with its sound fellow should not be neglected. No attempt at reduction should be made until all these points have been noted. Certain conditions, such as congenital dislocation, tuberculous disease of the joints, coxa vara, and malignant growths, should be excluded. The reduction is frequently complicated by the associated fracture and displacement of the fragments of the articulation, by laceration of the soft parts, and by inflammatory exudates and deposits. An excessive amount of callus about the joint will often complicate the reduction, but this and many of the other features already mentioned will be shown in the skiagram.



FIG. 713.—DISLOCATION OF LOWER END OF HUMERUS.

Accidents of great gravity are apt to occur during attempted reductions, such as laceration of the great nerves, rupture of important vessels, as the axillary, and cases have been recorded where the entire member has been torn from its attachment to the body. Willard has collected twenty-four cases in which there was injury to the axillary vessels during attempted reduction. Of these, there were fifteen which terminated fatally, two were uncertain, in one the axillary nerves were lacerated and in another the brachial plexus was torn from the spinal column. It is therefore very important to gage carefully just how much force may properly be applied in order to accomplish reduction without injury, and frequently it is better to forego any attempt to reduce the dislocation rather than to endanger the life of the individual.

Treatment.—The operative methods employed for the reduction of dislocations include traction and manipulation, extension and counter-extension, arthrotomy, and resection.

The methods employed by means of traction and manipulation are fully described in all text-books on general surgery and need not be epitomized here. Extension and counter-extension are not at the present time employed to any extent, since by means of the first method all that is possible can be accomplished except in those cases which require operative interference.

Arthrotomy. When manipulations have proved unsuccessful in reducing the dislocation, the joint should be opened and all the resisting structures should be incised. The greatest care in regard to aseptic precautions should be observed in all these operations. In addition to dividing the artificial fibrous bands and the removal of callus, the articular surfaces should be made more normal in outline, and foreign growths which have formed upon the surfaces should be removed. The joints most frequently requiring arthrotomy are the shoulder, elbow, and hip.

In the shoulder-joint access can best be obtained by an incision through the outer side of the cephalic vein. Occasionally it is necessary to make another incision on the posterior surface of the joint. In the elbow-joint arthrotomy is not very satisfactory, and it is usually necessary to resort to excision. When the head of the radius is dislocated, it may be advisable in order to obtain a useful joint to excise the head of the radius. In dislocation of the hip access can be had by an anterior incision from the anterior superior spine directly downward in the longitudinal plane of the limb. If fracture of the neck of the femur is found to coexist, the femur should be held in position by means of a screw inserted through the outer side of the trochanter in the direction of

the neck of the femur. The operation of Murphy, consisting of the interposition of fascias between the extremities of the joints, will be found valuable after the reduction of the dislocation if there is a tendency to ankylosis.



FIG. 714.—DEFORMITIES AFFECTING ANGLE OF KNEE-JOINT AND HIP-JOINT, FOLLOWING FRACTURE OF THE FEMUR.

Resection. Resection of the joint for unreduced dislocations is required only in exceptional conditions, and is most useful in the elbow-joint and hip-joint. In the shoulder-joint, on account of the great mobility of the shoulder-girdle, ankylosis is not so serious a matter as in some other articulations. In

performing excision in childhood it is necessary to avoid injury to the epiphysis so as not to interfere with the growth of the part. In the elbow-joint excisions frequently give very satisfactory results, and the functional use afterward is better than that which follows the operation of excision for tuberculous disease.



FIG. 715.—DEFORMITIES AFFECTING JOINT FOLLOWING FRACTURES OF TIBIA.

In the hip-joint, where the dislocation is irreducible by all known methods, excision may be undertaken, or in those very rare instances where the sciatic nerve is caught over the neck of the femur, excision will be found to be the only operation which will afford any relief.

If during the attempt to reduce the dislocation fracture occurs, as at the hip or shoulder, a better position may be secured or the deformity resulting may subsequently be corrected by osteotomy or osteoclasy.

The after-treatment consists in very early manipulations of the joint, massage, electricity, and passive and active movements. If on account of the length of time which has elapsed or for any other reason, reduction is impossible and resection is contraindicated, the limb should be put in the most favorable

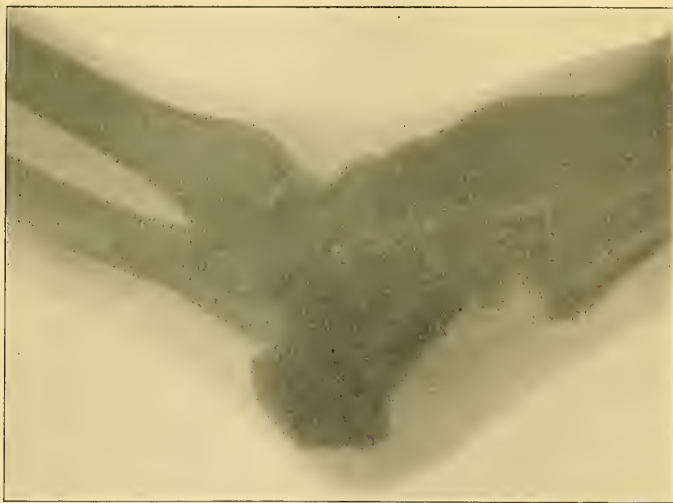


FIG. 716.—FRACTURE OF LOWER THIRD OF FIBULA WITH EXCESSIVE CALLUS, BEFORE OPERATION.

position and massage and manipulations should be employed to prevent ankylosis.

Displacement of the Sacrum.

Attention has recently been directed to displacement of the sacrum. This may occur at the sacroiliac articulation, and may be unilateral or bilateral. The erect attitude resembles that of sciatic scoliosis, but when the lower extremity is hyperextended, the patient being in the prone position, acute pain is experienced over the body of the gluteus maximus muscle from pressure of the internal lateral edge of the sacrum upon the sacral plexus of nerves. The

treatment consists in recumbency upon a pressure pad, followed by the use of pelvic bandages and supports.

Ununited Fractures.

As a result of improper setting, muscular action, or secondary displacement, vicious union often occurs, there being overriding of the fragments, angular deformity, or rotation of the fragments upon their long axis. The lower extremity is more frequently affected, there being in the 330 cases col-



FIG. 717.—THE SAME AS FIG. 716, AFTER SUBPERIOSTEAL EXCISION OF FIBULA.

lected by Bruns 275 in the lower and 55 in the upper extremity. The fractures in the vicinity of the joints are most productive of deformity, either from the fragments projecting directly into the articulation or from excessive callus. The articulating surfaces of the bones are often placed at a great disadvantage by the rotation of the fragments upon their long axis.

Ununited fracture or pseudoarthritis interferes with locomotion and demands orthopedic treatment.

The treatment of vicious union depends upon the character of the deformity and the time since the accident. If the callus is still soft, manual

refracture will be advisable, and the part should be fixed in plaster-of-Paris dressing. If two months have elapsed, osteotomy or osteoclasis will be found necessary to correct the angular deformity, the former operation being better near the articulation and the latter in the shaft of the bone. If the fragments are overlapping or project through the skin, it is sometimes necessary to remove a portion, and in some situations, as in the fibula or ulna, a subperiosteal exsection may be warranted, particularly if the lower fragment be greatly displaced into the joint. Cuneiform osteotomy is sometimes required to correct angular deformity.

In pseudoarthrosis the resection of the ends of the bones would be indicated, with wiring or plating of the fragments in proper position. The Parkhill plates will be found serviceable for this purpose. If the pseudo-arthritis be of recent origin, a leg brace will often allow the patient to walk, and the friction of the ends may be followed by firm bony union.

Rupture of Muscular Tissue and Tendons.

Traumatic rupture of muscular tissue has been referred to on several occasions throughout this work, as rupture of the quadriceps femoris, rupture of the biceps cubiti.

Ruptures of tendons from violence are not uncommon, but would be more frequently met if sprain fracture were not so common. The periosteum or bony attachment yields before rupture of the tendon can occur.

The tendons most frequently torn by external violence or muscular action are the rectus femoris, tendo patellæ, tendo Achillis, and flexor biceps cubiti. The first two have already been referred to under Non-tuberculous Diseases of the Knee-joint.

Rupture of the tendo Achillis is evidenced by a sudden snap, accompanied by a sharp pain back of the ankle, with loss of the function of extension of the foot and a distinct depression over the seat of rupture from separation of the retracted ends of the tendon. The treatment consists in exposing the tendon through a longitudinal incision over the back of the tendon, and suturing the torn ends with silk, silver wire, or chromicized catgut. The foot should be fixed with plaster in a position of extreme equinus for three or four weeks.

Rupture of the long head of the biceps cubiti is characterized by a relaxation of the outer half of the biceps muscle, with contraction of the inner portion. The treatment consists in the use of an anterior right-angled splint, or, better,

in suturing the torn ends together with chromicized catgut and fixation upon a splint.

Contractures and Ankylosis.

Contractures and ankylosis consist of partial or entire immobility of an articulation in any position, the former term being used when the causes acting to produce the immobility are extra-articular; the latter is used when the causes are intra-articular.

Synonyms.—*French*, Anchylose; Roideur Articulaire. *German*, Gelenkverwachsung; Gelenksteifigkeit. *Italian*, Anchilosi.

The term ankylosis (*ἄγκυλος*, crooked) is derived from the Greek root *ἄγκυλη* (*ankule*), originally used to express articular rigidity in a flexed position, the term *ὀρθόχολος* (*orthocholos*) being applied by Galen when the limb was fixed in a straight position. The word is now used interchangeably, the terms angular and straight being sometimes added, and the distinction being sometimes made of simple or complicated, associated with luxation. Two forms are recognized: true or complete, and false or incomplete. The ginglymoid or hinge joints are more frequently affected than the ball-and-socket joints.

Etiology.—Congenital ankylosis is rare; Helferich has noted congenital ankylosis in the interphalangeal joint of the thumb due to ossifying myositis. Shands, of Washington, has related to me a case of congenital ankylosis of both elbow-joints, an exceedingly rare condition. One case has been recorded, of a child twenty-three months old, with complete ankylosis of the entire skeleton.

The affection is usually acquired, as a result of non-use, or as sequel of articular disease, foreign bodies, or of fractures into the joints.

As the result of non-use, ankylosis is not uncommon in the aged in every position in society, and interesting examples have been recorded by Paget, Manzel, and Reyher.

The tubercular joint inflammations furnish the largest number, but gonorrheal, gouty, rheumatic, syphilitic, neurotic, and puerperal affections also lead to ankylosis.

The question of what produces and what prevents ankylosis has been a subject for discussion among surgeons for some time, some maintaining that if a normal joint be immovably fixed for a certain length of time, ankylosis will occur, and that motion is necessary in order to preserve the normal integrity of the joint and to prevent ankylosis in injured and inflamed articulations; while others have asserted diametrically the opposite.



FIG. 718.—FOREIGN BODIES IN KNEE-JOINT (Jones).

Both have used the fakirs of India, who for the sake of penance often assume one position for years, as an illustration; one claiming that their joints frequently become ankylosed in such an attitude (Schreiber), while another states that they, after holding their limbs in one position twenty years, quickly regain the normal use of their joints after their religious frenzy has passed (Thomas, quoted by Phelps).



FIG. 719.—COMPLETE BONY ANKYLOSIS OF ELBOW FROM FRACTURE OF HUMERUS.

The experiments of Phelps and Thompson appear to have proved that neither of these statements about rest and motion is correct, but that the question of ankylosis is determined by the severity, character, and duration of the inflammation, the presence of intra-articular pressure, the subsequent cicatricial contraction of soft parts around the joints, the tissue involved, and the amount of destruction of bone and cartilage. Contractures may be due to the following

causes: burns, lupus, ossifying myositis, adhesions between tendons and their sheaths or shortening by retraction, paralysis or division of nerves of antagonistic muscles, incised wounds of tendons, shortening of muscles following central and peripheral nerve affections; ischemic degeneration of muscles caused by constricting dressings, extensive destruction of tissue following phlegmenous ulcers, and occupational diseases in persons who do uninterrupted work of the same nature for long periods, as seen in "writer's cramp," etc.

Pathology.—In true ankylosis the articular ends of the bones are united by osseous material within the joint, without the joint as synostosis, or by both.

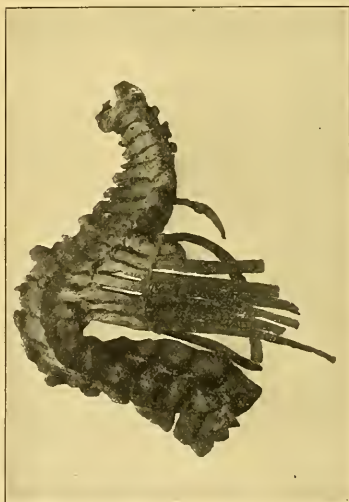


FIG. 720.—SCOLIOSIS, SHOWING DEFORMITY OF RIBS, WITH ANKYLOSIS.

Preceding the union of the bones there has been destruction and absorption of synovial membrane, of cartilage, and the joint has been obliterated by cartilaginous or fibrous material.

In false ankylosis the intra-articular changes are largely synovial, consisting of false bands, cicatricial contractions, cohesion of the ligamentous capsule, or complete disorganization by inflammatory deposits. Cicatricial contractions of skin, fascia, tendons of muscles, all are of this false variety.

Diagnosis.—A positive diagnosis between true and false ankylosis can

only be determined under anesthesia. When the ankylosis is osseous, the articulation remains immovable under complete narcosis.

Prognosis.—The prognosis at the present time is generally favorable under modern surgical methods.

Treatment.—Treatment should not be undertaken until the original articular disease has disappeared or has been overcome by appropriate treatment, since too early manipulation may hasten what the surgeon is striving to overcome.

The reduction in mild cases of false ankylosis can be accomplished by massage, and by gradual manual and elastic traction. In more severe cases forcible reduction (*brisement forcé*) may be performed with or without anesthesia. In doing this the rule employed by the bone-setter should be followed accurately, to make firm pressure upon the tender spot at the moment the greatest force is exerted. The greatest caution and gentleness are at first necessary until the rigidity begins to yield, lest fracture result, as it frequently has done in the hands of the most skilful surgeons.

The first movement should be in the direction of flexion, and forced flexion is often beneficial. When the false ankylosis is very firm, instrumental force must be resorted to, and osteoclasis of the preferred pattern may be used. Tenotomy is often required, and where necessary should be first performed.

In true ankylosis osteotomy or cuneiform resection is, as a rule, necessary; but amputation is rarely warranted since the advent of antiseptic surgery.

The consideration of ankylosis of the individual joints will be found in their respective sections.

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